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The proposition to elevate the tracks of the several railway lines entering Chicago is to be vigorously pushed by Mayor Hopkins, according to the Chicago papers. It is stated that an ordinance will be drawn up at once requiring the elevation of the tracks of one of the larger systems, probably the Lake Shore & Michigan Southern and Chicago, Rock Island & Pacific, or the Pennsylvania lines, and submitted to the officials of that system for acceptance, after which it will be submitted to the city councils with the recommendation that it be passed. The original ordinance for the suppression of grade crossings in Chicago was published in our issue of March 9, 1893.

The New York Rapid Transit Commission has had presented to it, by Mr. Jos. G. Hallam, a plan for a double tunnel on the route laid down by the commission. Mr. Hallam proposes to meet the objections made to the Reno tunnel plan by driving two tunnels, each 23 by 11 ft. in section, one slightly in advance of the other and one over the other, with 2 to 3 ft. of material intervening. He would lay the rails on feet set in concrete and weld the joints together to prevent rattling. The rectangular tunnels would be built up of cast iron plates, with center iron pillars, put in position by the Greathead method. He would use electricity for a motive power and for ventilation and light. He estimates the cost as being about the same as for the Reno system, or $30,000,000, and claims a minimum of danger to abutting property. He also says that the upper tunnel could be built first and operated until the traffic would warrant the construction of the lower section, each being designed for two tracks.

The railways of the colony of Western Australia have a gage of 3 ft. 6 ins. It is the same on the government and private lines, the latter of which have the greatest mileage, having been built on the land grant system. There is a small line of 2 ft. gage connecting Cossack and Raeburn, in the northwest portion of the colony, and belonging to the government. It is worked by horses, and up to two years ago was the only portion of the government railways that paid expenses. Western Australia is one of the best, but least developed, of the Australian colonies.

The trolley system of canal boat hauling, as recently tested upon a section of the Erie Canal, is thus officially reported upon by Mr. C. R. Barnes, City Electrician of Rochester, N. Y.: An average of 24.87 H. HP. was required to propel a full-sized loaded canal boat at the rate of 2.65 miles per hour against the current in the canal and a strong head wind. In the opposite direction, 26.21 H. HP. propelled the same boat at a speed of 4.24 miles per hour. The machinery, however, was not in proper condition nor well adapted for the purpose, as it is estimated that the inefficiency of the motor amounted to more than 20% of the whole power consumed. Mr. Barnes estimates that with a current of 500 volts, instead of the 300 volts obtained, the same speed should have been attained with an expenditure of not more than 21 E. HP. As to cost of operation, Mr. Barnes says that no definite figure can be deduced from these experiments. But he makes an approximate and conservative estimate as follows: With a steam and electrical plant capable of supplying power to 200 canal boats distributed over 50 miles of canal, and assuming that this plant is in operation only 210 days in the year, the cost would be somewhat less than 10 cts. per boat mile. If water power is available and can be cheaply developed, and the electrical power can be profitably utilized during the whole year in supplying manufacturers, the cost of canal propulsion would be correspondingly reduced.

A plan to abolish all grade crossings on Pennsylvania Ave. in Philadelphia, Pa., by depressing the tracks of the Philadelphia & Reading R. R. has been agreed upon by Mr. Jas. H. Windrim, Director Department of Public Works, and the officials of the railway company, and has been submitted to the city councils for action. The proposed improvement consists, in brief, in constructing an open subway from Broad St. to 21st St., and a tunnel from 21st St. to the open subway and cut south of Girard Ave. There will be no changes of grade except at 13th St. and at the point where the subway changes to tunnel on Pennsylvania Ave. In all 17 grade crossings will be abolished. It is estimated that the work will cost from $5,000,000 to $6,000,000, and of this amount one-half will be borne by the city and one-half by the railway company.

The most serious railway accident of the week was a collision between runaway cars and a freight train on the Buffalo, Rochester & Pittsburg R. R., at Warsaw, N. Y., Jan. 4. The first section of a freight train from Warsaw was to take on cars at Rock Glen. Ten empty coal cars and a caboose were left on the main track in the care of the flagman, who, it is said, had probably gone to sleep and failed to set the brakes. The cars and caboose ran back down the grade at great speed and struck the engine of th second section of the train, which was just pulling out of the Warsaw yard. The engine was damaged and six cars were wrecked. Two men were killed and another was seriously injured.

A locomotive boiler explosion occurred Jan. 1 at Higginson, Ark., on the St. Louis, Iron Mountain & Southern Ry. The engine was hauling a freight train at the time and several cars were derailed and wrecked. One man was killed and another was injured.

A serious fire occurred at the World's Columbian Exposition, Chicago, on Jan. 8. The Casino, Music Hall and Peristyle were destroyed, and considerable damage was done to the roof of the great Manufactures Building, while sparks from this roof started several fires among the foreign exhibits still remaining in the building owing to delay in the customs arrangements. The fire is believed to have been of incendiary origin, and the loss is estimated at about $100,000. Except for the fact that there was no head on the water pipes it is claimed that there would have been no loss.

The trestle accident of Dec. 15 on the Western New York & Pennsylvania, which caused the death of five persons and the injury of eight, has been investigated by the Board of Railroad Commissioners. Its inspector found that the trestle was originally a double track structure, the northern half being used by the New York, Chicago & St. Louis. This company changed the alinement of its tracks at this point in November, and sawed off and removed its half of the trestle. The structure was not braced longitudinally, except upon the south side, where there was one horizontal timber extending continuously between the caps. The trestle was about 25 ft. high with bents 17 ft. apart. The sills rested on shale rock in the creek bed and were leveled up with blocking at the time the north half was removed. The shale disintegrated rapidly under action of the elements. The creek crossed by the trestle runs nearly or quite dry in a summer drought, but carries a large volume of water when heavy rains occur. One bent of the trestle stood where it received the full force of the current and was (apparently) not parallel with it. The board recommends that the trestle be replaced with an iron or steel girder bridge on masonry abutments.

The coroner's jury which has been investigating the Louisville & Jeffersonville Bridge accident has rendered a verdict to the effect that the accident was due to negligence on the part of the Phoenix Bridge Co. in failing to take proper precautions to insure the safety of the falseworks.

A large water-works reservoir is to be constructed by the city of Newark, N. J., and bids for its construction will be received until Jan. 17. It is reported that the reservoir will be 1,082 × 1,215 ft. and will have a capacity of 285,000,000 gallons. Some of the principal items in the estimates are as follows: 475,000 cu. yds. of earth and 120,000 of rock excavation; 42,500 cu. yds. of concrete; 1,510,000 sq. ft. of asphaltic cement and felt lining; 170,000 sq. yds. of brick paving, 40,000 of which will be on slopes; 51,000 sq. yds. of soiling and seeding; 200 tons of pipe and special castings. Mr. Chas. H. Jacobsen is engineer of the Water Department of the Street and Water Commissioners of Newark.

The report on the mineral production of the United States for the calendar year 1892 has just been issued by the Division of Mining Statistics. The summary given below shows a total valuation of $685,377,383.

Products.	Quantity.	Value.
Pig iron tons	9,157,000	$131,161,039
Silver, ounces	55,000,000	74,989,000
Gold, ounces	1,595,375	33,000,000
Copper, pounds	353,275,742	37,977,142
Lead, tons	203,262	17,069,960
Zinc, tons	87,200	9,027,920
Quicksilver, flasks	27,993	1,245,689
Nickel, pounds	94,252	50,733
Aluminum, pounds	259,895	172,824
Tin, pounds	162,000	32,400
Bituminous coal, tons	113,261,792	125,124,381
Pennsylvania anthracite, tons	46,850,450	82,442,000
Building stone	.....	48,706,625
Petroleum, barrels	50,509,136	25,901,436
Lime, barrels	65,000,000	40,000,000
Natural gas	.....	14,890,714
Cement, barrels	8,728,621	7,152,750
Salt, barrels	11,698,800	5,654,915
Phosphate rock, tons	684,574	3,296,227
Limestone for iron flux, tons	5,172,112	3,620,480
Mineral waters, gallons sold	21,876,604	4,905,970
Zinc white, tons	27,500	2,200,000
Potters' clay, tons	420,600	1,000,000

The metals were valued at $304,775,379; non-metallic products, $370,607,864; unspecified products, $10,000,000. The report makes a volume of nearly 900 pages, and is composed largely of papers by experts on the various subjects discussed.

The steel railway bridge over the Missouri River at Leavenworth, Kan., which has been under construction since December, 1892, was opened for traffic Jan. 2. The bridge proper, that is the portion constructed of steel and iron resting on masonry piers and extending across the main channel of the river, consists of one swing span 440 ft. in length and two fixed spans of 330 ft. each, making a total length of 1,100 ft. The spans are supported on five masonry piers, the extreme east and west piers resting on pile foundations and three interior piers, including the one under the swing span, being built on pneumatic caissons extending down to the rock, which is penetrated some distance by the cutting edge of the caissons. The five piers comprising the substructure contain about 2,200 cu. yds. of masonry, and the foundations under them about 3,000 cu. yds. of concrete. In the caisson there are about 400,000 ft. of timber and about 100 tons of iron and steel. The cost of the substructure complete in place, together with the dike, protecting the east approach, was about $175,000. The superstructure, comprising the three spans above mentioned, contain 1,300 tons of iron and steel, and cost $110,000. The entire cost of the structure, together with the tracks, terminal buildings, freight depot, switches, etc., was about $525,000 in cash. The east approach to the bridge is 3,000 ft. long, and consists of an embankment 20 ft. high, made of dirt and slate. It is protected by a dike 3,500 ft. long. The two railways using the bridge and terminal depot are to pay a rental of $18,000 a year each. The charter for the bridge was secured from Congress in 1884, but the Leavenworth Terminal Ry. & Bridge Co., which built it, was organized only two years ago, with Mr. E. W. Sydere, of Leavenworth, Kan., as president, and Mr. A. J. Tullock as chief promoter of the enterprise. Contracts for building the bridge were let on Dec. 8, 1892, and work commenced on Dec. 20. The substructure was built by the Missouri Valley Bridge & Iron Works and the superstructure by the Union Bridge Co., of New York city.

A bridge across the Kill von Kull, connecting Bergen Point and Staten Island at points a little east of the present ferry line from Bergen Point to Port Richmond, is stated to be contemplated by the syndicate of Philadelphia and New York capitalists, which controls nearly all the electric railways in Newark, Jersey City and the Oranges. This syndicate is reported to have secured a large amount of land in the interior of Staten Island, and it is to open this up to suburban residents doing business in New York that the bridge and connecting railway lines are to be built. At present the only connection with the interior of the island is from New York by boat to St. George, then by rail to West New Brighton or Stapleton, and thence by horse car inland. As for the bridge itself it is proposed to have it high enough above the water to permit tugs and other small craft to pass under, while a swing span will provide for the passage of larger vessels. The consent of Congress will have to be obtained for its construction.

EXPERIMENTS TO DETERMINE THE HOLDING POWER OF NAILS AND DRIFT BOLTS.

By F. W. Clay, C. E., Richmond, Ky., Graduate in the Class of 1893, Cornell University.

(Awarded Second Prize in Engineering News Thesis Competition of 1893.)

The following paper consists mainly of the results of some experiments made by the author on the various properties and characteristics of the several kinds of nails in common use, together with a theoretical description of the phenomena observed and some discussion of their meaning and their application in practice. It has been attempted by the strict rules of experimental study to draw some practical conclusions on the subject of the holding power of nails and drift bolts. Statements of others have not been quoted without good reason for believing them well founded, and the writer has tried to state only those facts that actual experiment has forced him to accept. A description of the method of testing and of the materials used, etc., is appended.

There seems to have been very little written, at any time on this subject, and in fact, very little thought has been expended upon it. All that has been presented seems to be largely repetitions of and quotations from Professor Bevan's experiments on the relative holding power of nails in various kinds of woods.

The question of the proper design and use of nails might on first thought appear to be of small moment, but a little investigation will show that it is in such small things as this that economy is most needed—economy in material, in design and in use. It is of the highest importance to get the greatest possible efficiency out of even such small tools as these. Waste in the employment of implements of such common use, and singly of such small value, will amount in the long run to startling figures. It will be found that here questions of economy are of very far-reaching importance; largely because the implements are so small in value as to easily escape our notice, while waste inefficiency and expensive modes of manufacture in larger things challenge attention at once, and are therefore corrected.

Whether we should make and use cut or wire nails, whether nails should be barbed or not, whether drift bolts should be round or square, and other similar questions will be seen to be of great importance when we consider that some 115 nail manufactories were at work in the United States in 1882, putting out about 500,000 tons of nails, representing a value of nearly $6,000,000, and that the deciding of some of these questions may easily change by as much as 50% their value and usefulness. Experiment in even such things is of very great value; it is a significant fact that the manufacturers have been spending much extra material and labor in order to barb nails and drift bolts on the one hand, and to make a very smooth surface on some (the wire nails) on the other hand, when a little investigation clearly shows that in both cases the efficiency of the nail is very greatly decreased.

In the experiments I have carried on, I have attempted to decide:

1. The relative merits of cut and wire nails.
2. The proper surface for each kind.
3. The proper shape, point, etc.
4. The best length, and best relation between length of nail and the thickness of board nailed.
5. The relative holding power in different kinds of wood.
6. The effect of time on holding strength.
7. The best method of driving.
8. The approximate stress nails may be expected to stand in direct tension, and in shearing of pieces; and driving stress compared to drawing stress.
9. The holding strength when subject to impact.
10. Comparative merits of round and square drift bolts.
11. The proper relation between the diameter of a drift bolt and the hole it is driven into.

Prior to the beginning of this century practically all nails were made by hand of a good quality of wrought iron. The first nail machines on record were constructed in 1790, and made wire nails, probably on account of the ease with which wire could be made, and its cheapness. Not until the introduction of machine-made nails were nails of anything like uniform size. Hand-made nails were measured and named by the weight of 1,000 nails; the term "four-penny nail," still used, is a corruption of "four pounds of nail," and meant then a nail of which it took 1,000 to weight 4 lbs. The term has now only an arbitrary relation to the size of the nail. Some term should be adopted in its place which should indicate the sizes of nails. A good plan would be to number them according to their length in inches, and indicate their diameter in eighths written under the number. Thus, a 3-1-nail and a 5-2-nail would be, respectively, a 3-in. nail with ⅛-in. mean thickness, and a 5-in. nail, ¼-in. thick.

Though it is a quite general impression that the wire nail is a new invention that is about to replace the "old" cut nail, the fact is that while wire nails were made in 1790, the first cut nail machines only came into use in 1812, and the first machine to equal the performance of a wire nail machine was built in 1821, and turned out 100 nails per minute. In 1892 the number of cut nail machines in this country was 6,100; and about 1,800 wire nail machines, in some 30 or 40 factories, were in use. The cut nails are still vastly in predominance in use. The probable reason for the growth in popularity of the wire nail is that it is clean, regular in size, looks well, is easily driven, and as a rule, is apparently not so liable to split the wood. For real utility, however, the cut nail seems to be far in advance of the wire nail.

In the holding power itself of either kind, it becomes evident upon some thought and a little experiment that to attempt to find the absolute tension to be withstood by a nail in drawing from this or that wood, would be wasted energy; because the conditions of the holding strength, i. e., the kind of wood, state of seasoning, mode of driving, time the nail is in the wood, the coarseness of the grain and the relation of the nail's surface to it, the exact mode of drawing, etc., are very variable and never to be foreseen. The results herein are mostly comparative, and only approximate values of the actual tenacity were obtained.

Wood consists of tubular fibers of varying size, thickness of wall and hardness of tissue. The tenacity with which the nail stays in wood depends, of course, on the friction between these fibers and the nail's surface. The important point is, therefore, the relation between these things. When a pointed nail is driven, it forces the fibers to the sides (Fig. 1) and the longitudinal elasticity as well as the transverse keeps them pressed against the sides of the nail, unless the fibers are torn apart lengthwise. The wedging of the nail between the fibers is what causes this pressure, and the tendency to split the wood is a direct measure of the lateral pressure, and, therefore, of the friction and of the holding strength. The idea that a wire nail will not split the wood as easily as a cut nail of the same strength, is erroneous. If a wire and a cut nail are wedged with equal tenacity, the wire must have far the greater tendency to split the wood, for this reason. The only considerable pressure against the wire nail is due to the wedging apart that the point accomplishes in going in, and is easily seen to be almost entirely on the two sides parallel to the grain (Fig. 1), but when the square nail, not pointed, enters the wood, the edges on the end shear off and bend down the fibers that they meet at right angles and there is little or no wedging sidewise or across the grain (Fig. 2). As the nail goes in, its two sides that are perpendicular to the grain are wedged, and press back these fibers still more. Then when the nail receives a withdrawing stress, these fibers act like barbs, and besides the pressure they create in their tendency to straighten up, they receive a direct thrust. It was shown that the main part of the tenacity in this case was due to this action on the ends of the fibers by driving a nail as shown in Fig. 3, between two holes so that only the ends of fibers came into contact with the surface, and comparing this with the tension withstood when driven as usual. The drawing tensions were 635 lbs. plain (Fig. 2), and 590 lbs. as driven between holes (Fig. 3).

It is then plain that pointing an ordinary cut nail should increase its holding power very much, causing it to stick by both the method of the cut and the wire nail. Experiments described in the latter part of this paper confirm this theory, the tenacity being increased by 32%.

Former Experiments.—Some very conclusive experiments were made at the Watertown Arsenal in January, 1893, on the comparative direct tensile adhension in pine and spruce, of cut and wire nails. The results of the tests were assimilated and reduced to concise conclusions by Prof. W. H. Burr, as follows:

There were 58 series of tests, ten pairs of nails (a cut and a wire nail in each) being used, making a total of 1,160 nails drawn. The tests were made in spruce wood in most instances, but some extra ones were made in white pine, with "box nails." The nails were of all sizes, varying from 1¼ ins. to 6 ins. in length. In every case the cut nail showed the superior holding strength by a large percentage. In spruce, in nine different sizes of nails, both standard and light weight, the ratio of tenacity of cut to wire nail was about 3 to 2, or as he terms it, "a superiority of 47.45% of the former." With the "finishing" nails the ratio was roughly 3.5 to 2, superiority 72%. With box nails (1¼ to 4 ins. long) the ratio was roughly 3 to 2, superiority 51%. The mean superiority in spruce wood was 61%. In white pine, cut nails, driven with taper along the grain showed a superiority of 100%, and with taper across the grain of 135%. Also when the nails were driven in the end of the stick, i. e., along the grain, the superiority of cut nails was 100%, or the ratio of cut to wire was 2 to 1. The total of the results showed the ratio of tenacity to be about 3.2 to 2 for the harder wood, and about 2 to 1 for the softer, and for the whole taken together the ratio was 3.5 to 2. We are unquestionably led to conclude that under these circumstances the cut nail is superior to the wire nail, as far as direct tensile holding power is concerned, by 72.74%.

But these results being only in one class of wood and touching only the direct tensile tenacity, the author made further investigations. Nails of the two kinds, being of the same size approximately, the wire nails being plain, were driven into hard red oak, and pulled by slow and regular machine power, by means of an Olsen testing machine in the Sibley College laboratory. The tension invariably reached a maximum before the nail started. The arrangement was such that each nail was pulled separately, in the direction it was driven, and all were pulled at the same rate of speed. The results in Table I. are the means of three trials each:

TABLE I.—Resistance of Wire and of Cut Nails to a Straight Pull.

Nail.	Size. ins.	Area, sq. in.	Wght, gram.	Stress, lbs.	Ratio of stress to w'ght.	Ratio of stress to area.
Cut 12d.	4 × 0.21 × 0.185	3.16	19.5	1,990	101	620
Wire 20d.	4 × 0.186	2.34	15.1	1,220	81	530
Ratio, by area, 6 to 5		Ratio, by wghts., 5 to 4				
Cut 6d...	2.5 × .12 × .14	1.3	4.8	1,023	210	787
Wire 10d.	2.75 × .136	1.17	5.	579	116	482
Ratio, by area, 1.4 to 1		Ratio, by wghts., 1.8 to 1				

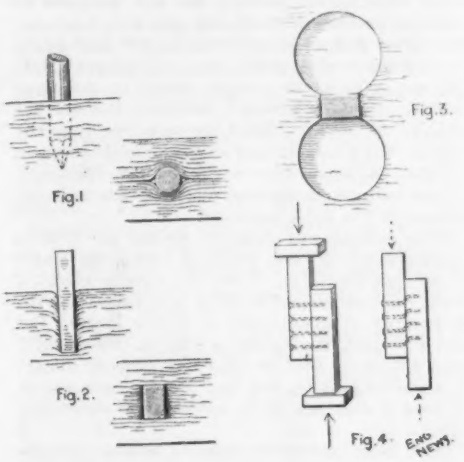
The comparison by weight of the nail is the fairer, because one of the very points of superiority of the cut nail is that it has more surface to the unit amount of material, the perimeter of its square section being to that of a circle of the same area as 7.1 to 6.2.

TABLE II.—Holding Power of Wire and Cut Nails Subjected to Shearing Strain.

Kind of wood, size, etc.	Size of nail.	Area of nail in wood. Sq. in.	Weight of nail.	Stress per nail.	Ratio of stress to weight.	Ratio of stress to area.
Two slabs of 2-in. Georgia pine.....	12d. cut	3.16	19.5	930	48.7	29.7
	20d. wire	2.34	15.1	745	49.3	31.8
Ditto, White Pine.....	12d. cut	3.16	19.5	905	46.4	28
	20d. wire	2.34	15.1	540	35.7	±3
1-in. Ga. pine to 5-in. hemlock.....	20d. cut	Hemlock, 1.95	19 5	870		448
	20d. wire	1.6	15.1	647		404
1-in. Ga. pine to 3-in. oak.....	6d. cut	Oak, .73	4.8	527		110
	10d wire	.71	5.0	536		105

But nails are more frequently subjected to a shearing strain, as when two planks are nailed together to prevent sliding on one another. For testing under these conditions, two pieces of wood were nailed flat together, and subjected to a shearing strain (Fig. 4) by means of the Olsen machine. The nails were not driven quite up to the head, so that no strain came on the head. In an isolated case where they were driven close up the wire nail seemed to be at a greater disadvantage still.

Table II. shows, in the comparison by areas of the nails, in the first case with Georgia pine, a superiority of about 6% for the wire nail, but in the second, third and fourth cases, about 22%, 11% and 5%, respectively, inferiority to the cut



nails. Compared by the fairer standard of weight, the advantage of the cut nail is still greater. The isolated case of the wire nail being strongest is apparently explained by the fact that in the Georgia pine the grain is very coarse and irregular and the nail pierces layers of the hard pitchy sap which has no grain and which does not split easily, as a rule, in this kind of strain. While the square nail abuts directly against the ends of the fibers the round nail wedges itself between them and meets less resistance. For this reason the wire nail often splits the wood and the cut nail very seldom does in this kind of strain. It is worth noticing that the cut nail is always at its greatest efficiency in the softer woods, while the wire does best in the harder varieties. It was also noticed that the tendency to split was comparatively greater for the cut nail in softer woods, and for the wire nail in the hard woods. This is as might be anticipated, for the tendency to split is a direct measure of the lateral pressure, therefore, of the friction, and hence the holding power, as before pointed out.

From the above discussion it is evident that the cut nail has the advantage (1) by reason of its greater amount of surface, and (2) because of its wedge shape. Comparing the tenacity as driven with the wedge along the grain, to that when driven with the wedge across the grain, the withdrawing tension was found as follows for white pine:

Wedge along grain	368 lbs.
Wedge across grain	520 "
Difference	152 lbs.
Difference, per cent	41.3

In the report of the Watertown Arsenal for 1884 are found some experiments of a similar nature, giving the results, shown in Table III.

TABLE III.—Comparative Holding Power of Cut Nails with Wedge Driven Along the Grain and Across It.

Wood.	Wedge driven—Along gr'n.	Across gr'n.	Difference.	P.c. inc.
White pine	340 lbs.	460 lbs.	120	35.
Yellow pine	660 "	768 "	108	16.3
White oak	1,018 "	1,158 "	140	13.7

These experiments point to the same conclusions as the above, and in that case, white pine, agree quite closely with my own tests. Later, it will also be seen that the wire nail has the advantage of being pointed and of having a better surface.

It is evident that any sharp angular projections on the surface of a nail, either in the form of small barbs or the roughness left by the cutting machinery, will in driving tear the fibers of the wood in immediate contact with them. This will lessen to some extent the elasticity and the pressure of those fibers, and further, will, by forming a dead cushion, prevent the other fibers in the neighborhood from exerting their full pressure. We might expect then that barbed nails were not so good as plain nails. In accordance with this theory, experiment shows that sharp barbs are detrimental; but if the wood fibers are very elastic and spongy, and if the projections on the nail's surface are themselves smooth, as is usually the case with the so-called "barbed" wire nails, it is found that they do not tear the fibers, but that the nail holds better on account of them. It seems probable that the greatest possible friction along the surface would be obtained when the roughness of the surface corresponded somewhat to the size of the fibers, so that the latter might interlock with the minute projections of the surface. If the surface is too smooth, the fibers find no projection to catch behind and the friction is small. The ordinary "barbs" are not properly barbs, but rounded projections, and they act as a kind of shelf, behind which the elastic fibers expand after driving, and when the nail is drawn act as a wedge, bringing into play many more of the surrounding fibers. When, however, these projections are rough or sharp, so as to cut the fibers, they prove in every case detrimental.

Experiments were made on a lot of wire nails kindly furnished by the New Castle Wire Nail Co. and the Braddock Wire Co., and cut nails obtained at the stores, all of which were the very best of their kind. The manufacturers all seem to employ an excellent quality of wire in making the nails, and samples sent by the above companies when tested showed it to be of a quality which seems to the writer unnecessarily good. Economy here might well be practiced; a poorer quality of wire, if not too soft, would answer as well for nails. The very longest nail used cannot be subjected to a strain greater than about 35,000 lbs. per sq. in., while the samples tested withstood 72,000 lbs. The ordinary tension on a wire nail is from 18,000 lbs. per sq. in down, depending on the wood and on its length.

For comparison of surfaces in various woods, and drawn parallel to the nail's length, the results in Table IV. were obtained. They indicate the comparative merits of (1) plain, (2) barbed, and (3) "blued" surfaces on wire nails; the latter surface being slightly granular and rough in character, and apparently having a thin coating of some oxide of iron. It rusts very quickly, and in preparing it the metal is made quite soft, which is a very objectionable feature, as in driving, an average of two nails were spoiled to every one spoiled of the other kind.

The results in Table IV. are the mean of several tests as indicated, and they fairly represent various conditions of driving, time, and kind of wood.

TABLE IV.—Effect of Surface of Wire Nails on Holding Power. (Each figure is the average of four trials.)

Size of Nail.	Mean tenacity, lbs.—Plain surface.	Barbed surface.	Blued surface.	Remarks and conditions.
6d	204	345	591	Wh. oak, 1 week.
6d	226	300	555	" 10 weeks.
6d	437	350		" dr. at once.
6d	253	340		" 1 week.
6d	300		550	" 2 months.
	284	334	565	Mean in oak.
20d	1,043	800	1,285	Oak 1 day.
6d	412	262	355	Hemlock (at once).
6d	183	260	470	" 2 hours.
6d	155	232	425	" 2 days.
6d	141	201	319	" 9 weeks
	222	241	392	Mean in hemlock.
10d	210	176	126	Mean white pine.
50d	1,010	875	980	Wh. pine, 1 month.
20d	480	270	465	" "
20d	380	600	685	Yel. pine, 6 weeks.
20d	400	530	513	" 8 "
6d	190	130	270	" 2 months.

These results show great variation, and I think allow us no more exact conclusion than this; that the barbed nail averages slightly greater resistance to pulling than the plain (smooth), nail; and that the blued nail is much superior to either in holding power. Taking into consideration the extra cost of making, and the extra material used in the barbed nails, it is certain that they should not be manufactured or used from any economical considerations. In the cases where the nails were driven for some time, the blued nail usually became rusted, and this increased the holding power by the oxide sticking to a mass of fibers in clots which, of course, increased the resistance to withdrawal.

In the report of 1884, mentioned above, we find some results from barbing cut nails. In this case the barbs were really such, being sharp and angular and probably cut the fibers of the wood. In all cases the nail's holding strength was injured, as shown in Table V.

TABLE V.—Effect of Sharp Barbs on Holding Power of Cut Nails.

Nail.	Wood.	Stress per sq. in. in wood, lbs.—Plain.	Barbed.	Diff.	Ratio.
60d	White pine.	222	166	56	1.34
60d	Yellow pine.	660	473	187	1.39
20d	" "	477	397	80	1.20
60d	White oak.	1,018	846	172	1.20
20d	" "	1,021	766	254	1.33
60d	Chestnut.	702	618	84	1.13

The surface on the flat side of the ordinary cut nail is very near the ideal; the taper side is too rough. Wire nails should neither be barbed nor smoothed. The wire in its natural state as drawn is nearly right. Some wire nails were barbed by cutting with a chisel; then driven and compared with the plain, with the following results:

	Tension to draw, lbs.
Barbed	310
Plain	397

These results are from three nails of each kind driven into the same piece of yellow pine.

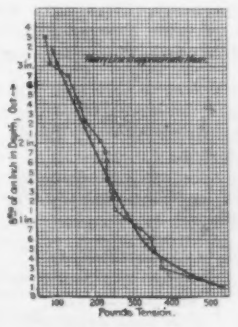


FIG. 5.

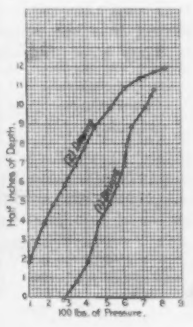


FIG. 6.

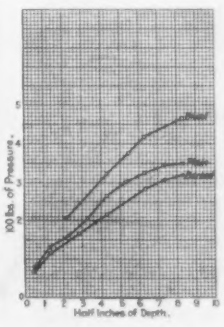


FIG. 7.

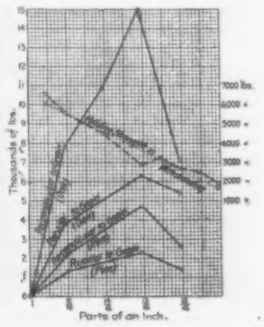


FIG. 10.

Some experiments have been made elsewhere of a similar nature on drift bolts, and there, too, the barbing was found to be detrimental.

It might be supposed that the holding power of a nail was directly proportional to the area of its surface in the wood. This is not the case. Bevans, in his reports of experiments on nails, states that the resistance to drawing varies as $\frac{3}{4}d$, where d is the depth. He gives the following as the resistance to driving a 6d. nail in "deal" wood at various depths:

Depth, ins.	¼	½	1	1½	2
Pressure in lbs.	24	76	235	400	610

The resistance to driving and that to drawing vary in about the same ratio. Bevans states that the former is about 120% of the latter, which agrees fairly with the above. I tried experiments in driving and drawing nails by slow machine power, and taking the stress at various depths. In Table VI. is shown the results of these observations. There

were two nails, each of the three kinds, plain, barbed and blued, all 20d., all driven at once into white pine, and drawn, of course, one by one, but under exactly similar conditions.

TABLE VI.—Pressure Required to Drive 20d. Wire Nails in White Pine.

Depth in ins.	Pressure for driving, lbs. Plain.	Barb.	Blued.
¼	73	...	...
⅜	127	110	...
1	157	...	...
1⅛	200	...	...
2	240	210	217
2⅛	267	...	...
3	317	...	...
3⅛	333	300	...
4	...	...	453

The curve, Fig. 5, is from observations in drawing a 20d. nail very carefully from yellow pine. The heavy black line equals the approximate curve, which would probably be a parabola if ideal. Fig. 6 shows the curves obtained in driving and drawing 50d. nails in white pine. The relation of the driving pressure to the depth seems to roughly approximate a straight line, while that of drawing is similar to a parabola, as stated before. The experiments made on the several kinds of nails separately gave the curves in Fig. 7 for driving in white pine. In Tables VII. and VIII. are shown the results obtained in driving and pulling 50d. nails in white pine.

TABLE VII.—Pressure Required to Drive Six 50d. Nails Into White Pine.

Depth, ins.	Pressure, lbs.	Press. per nail lbs.
¼	1,300	217
⅜	1,700	283
½	2,060	343
⅝	2,250	375
1	2,420	403
1⅛	2,780	463
1½	3,000	500
1⅝	3,200	541
2	3,320	553
2¼	3,500	583
2½	3,950	658
2⅝	4,200	700
3	4,580	763

TABLE VIII.—Force Required to Pull 50d. Nails Driven Into White Pine.

Depth, ins.	Tension on nails, lbs. Plain. 1.	Plain. 2.	Barbed. 1.	Barbed. 2.	Blued. 1.	Blued. 2.	Mean (total).
3	1,190	830*	770	980	1,060	900	905
2¾	700	...	420	580	550	500	550
2½	600	520	300	440	530	450	473
2¼	540	440	270	350	380	340	387
2	460	390	210	280	380	310	335
1⅝	360	350	180	220	290	270	278
1½	340	270	140	180	210	200	223
1¼	280	220	100	160	150	150	167
1	140	160	80	80	120	100	113

* Split.

TABLE IX.—Variation in Holding Power with Depth, 20d. Nails.

Depth, ins.	Stress in lbs. Plain.	Barbed.	Blued.
4	430	410	....
3	340	210	....
2	210	200	....
1	75	...	....
	50d. Nails.		
6	990	...	....
3	400	...	....
2	250	...	....
	20d. Nails in White Oak.		
3	...	...	1,500
2½	740	736	1,224
2	476	564	1,090
1	310	200	518

It is evident that the holding power does not vary directly with the depth, but the results seem to be too irregular to decide the law of the variation. To find the effect of depth on the holding power with separate nails, I drove some to various depths in the same piece of wood and noted the stress required to draw them. The results are shown in Table IX. These results are too irregular to enable us to deduce any law from them.

While the decrease of tenacity of the wire nail is quite gradual, as it is withdrawn, it is found that for the cut nail it very rapidly and suddenly falls off after starting the drawing. This fact is worth remembering in comparing the values of the two kinds. Nails are often used in joining pieces that are subject to vibrations. The cut nail will jar loose much easier and being partly withdrawn loses a large part of its strength. This is, of course, on account of the fact that the wedge side induces most of the pressure.

It has been already shown that the square section for the nail is better than the round section. Nails are generally used of a length about 2½ times the thickness of the thinnest piece nailed. I made some experiments on the length, the results of which are shown in Table X. Cleats of varying thickness were nailed to a pine block and then subjected to a shearing pressure. All the nails were 6d. plain, 2 ins. long, and there were two nails to each cleat.

TABLE X.—Effect of Length of Nail in Wood on Resistance to Shearing.

Thickness of blocks, ins.	Stress, lbs.	Remarks.
¼	430	Heads pulled through
⅜	475	Piece split
½	460	
⅝	485	
¾	434	Heads pulled off
1	380	One head pulled off

From this it will be seen that the greatest tenacity was when the piece nailed was less than half the nail's length. There is not much variation as long as at least half the nail is in the ground piece, on the one hand, and the slab is not thin enough to split, on the other.

The following abstracts (Table XI.) from the results of some experiments at the Watertown Arsenal (1884) show that there is no definite relation between the size of the nail and the holding power per unit area in the wood:

TABLE XI.—Showing Effect of Size on Holding Power per Unit Area in the Wood.

Size of nail.	Length driven, ins.	Surf. in wood, sq. ins.	Adhesive resist., lbs. Total.	Average Total.	Average Per sq. in.
8d.	1.5	0.705	306		
"	"	"	264		
"	"	"	346	317	450
"	"	"	332		
"	"	"	338		
9d.	1.75	0.857	362		
"	"	"	504		
"	"	"	340	390	455
"	"	"	356		
10d. F.	2.25	1.967	422		
"	"	"	340		
"	"	"	486	407	421
"	"	"	380		
20d.	2.5	1.55	920		
"	"	"	710		
"	"	"	770	740	477
"	"	"	580		
50d.	3.0	2.64	1,020		
"	"	"	845		
"	"	"	882	915	347
"	"	"	912		
60d.	3.0	2.79	980		
"	"	"	1,056		
"	"	"	950	976	350
"	"	"	918		

An important point in the shape of nails is the form of its driving end. I have mentioned the theoretic action of the point of wire nails in entering the wood. The experiments made on this point bear out the theory perfectly. Wire nails were ground into the shape of point illustrated in Fig. 8. They were then all driven in the same piece of

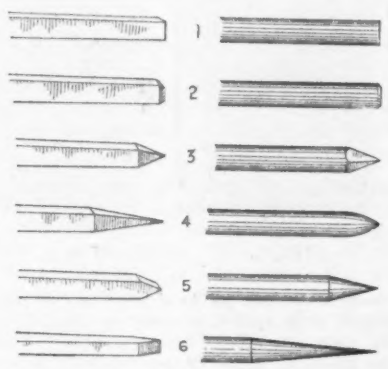


Fig. 9. Fig. 8.

wood and pulled with a small Olsen machine, at once. The results are given in Table XII. and each is the mean of three nails.

TABLE XII.—Effect of Shape of Point of Nails on Holding Power.

Wire nails. No.	Holding strength, lbs.	Cut nails.	Holding strength, lbs.
1. No point	449	Blunt	1,200
2. Edges ground off	810	Edges beveled	1,405
3. Pyramid point	997	Pointed	1,592
4. Round point.	840	Sharp, slender point	982
5. Sharp point	1,055	Wedge point, taper side	1,250
6. Extremely sharp	1,026	Wedge point, flat side	1,440

From this it appears that the pointing of the wire nail increases its holding power by 122%, and even the slight wedging accomplished by having beveled edges increases it by 78%. Wire nails, it appears from this, should be slightly more pointed than usual, and the point is better pyramidal.

In the case of cut nails the same general conclusions as to pointing hold good, as will be seen from similar experiments (Fig. 9, Table XII.). The nails were all 12d. and were driven into yellow pine.

As it would cost but little extra to point the ordinary cut nails, and as it is seen to increase the efficiency by 30%, it would be highly advantageous to manufacturers to note these facts. Doubtless to some small extent pointing the nail increases its tendency to split the wood, but this is no detriment, but rather just what we want, for this tendency is the holding power, as has been pointed out. Making the point a sharp short wedge on the taper side of the nail, however, does not increase the liability to split the wood, as nails are generally driven. The heads of nails should be made stronger, as they do not always withstand the concussion of the hammer in driving, and they are very important in the nail's functions.

With ordinary cut nails the weight per 1,000 is approximately 21^2 lbs., where 1 equals the length of the nail (Bevan's). From the samples I used, I found the length equal to 102 A ins., where A is the mean area of cross-section in square inches. For the wire nail, the length is 144 A. Short thick nails should be used in fastening timbers subject to a shearing strain, and long slender nails should be used if they are to be subjected to direct tension.

Table XIII. shows the relative holding strength of different sized nails subjected to a shearing strain. They were all driven the same depth into yellow pine, and held on cleats of oak. The cleats were slid along the surface. The maximum pressure occurred very soon after the cleats began to move.

TABLE XIII.—Showing Resistance of Different Sized Nails to Shearing Stress.

Size of nail.	No. of nails.	Area in wood, sq. ins.	Stress per nail, lbs.	Stress per unit of area.
50d (plain)	3	0.833	816	1,015.6
20d	3	0.58	533	918.9
18d	3	0.566	490	865.7
15d	4	0.471	375	796.2
10d	5	0.427	452	1,058.5
6d	6	0.33	283	857.5

It seems the same amount of area, in small nails or in large ones, will hold about the same amount, but if there is any preference, it seems to be in favor of using a few large nails rather than many small ones.

Almost all the experiments that have been made on nails have been attempts to find how much tension a nail driven in the various kinds of wood will withstand, in the direction of its length, before being withdrawn from its place. This seems to be of little importance relatively, because not only are there never two pieces of wood alike, but even on the same piece, with the same nail, driven the same way, it is impossible to obtain two cases in which the conditions are the same. I experimented only on two or three of the commoner kinds of woods, and mostly with wire nails.

Mr. Bevans in some experiments made long ago, with 6d. nails, found the following results*:

Holding Power of a 6d. Nail Driven to a Depth of 1 in., lbs.

Kind of wood.	
Deal	187
Oak	507
Elm	327
Beech	667
Sycamore	342

He found the resistance to driving to be roughly 20% greater than the resistance to drawing, and to vary with the depth, as is shown by the curve in Fig. 10, which approximates a parabola.

From the extensive experiments recorded in the Watertown Report 1884 (p. 452), I have condensed the following table, showing the relative holding powers for several kinds of wood, for both cut and wire nails.

Table XIV. comprises mean results for all sizes of nails and several samples of wood.

* Thurston, "Materials of Engineering."

TABLE XIV.—Nail-Holding Power of Various Woods (Watertown Experiments).

Kind of wood.	Size of nail.	Holding power per sq. in. of surface in wood, lbs. Wire nail.	Cut nail.	Mean.
White pine..	8d.	167	450	405
	9 "		455	
	20 "		477	
	50 "		347	
			363	
	60 "		340	
Yellow pine.	8 "	318	695	662
	10 "		735	
	50 "		598	
	60 "		604	
White oak..	8 "	940	1,340	1,216
	20 "		1,292	
	60 "		1,018	
Chestnut....	50 "		664	683
	60 "		702	
Laurel.....	9 "	651	1,179	1,200
	20 "		1,221	

In my own experiments I found the holding power as in Table XV., all the values being for 6d. nails, with surfaces as indicated in each case.

TABLE XV.—Nail Holding Power of Various Woods (Author's Experiments).

Wood.	Tenacity of 6d nails. Plain.	Barbed.	Blued.	Mean
White pine	106	94	135	111
Yellow pine	190	130	270	196
Bass wood	78	152	219	143
White oak	225	370	555	360
Hemlock	141	201	319	220

Bevans also made some experiments on the holding power of railway spikes in different woods. A spike is nothing more than a large nail, and the results are much the same as for nails. His results are given in Table XVI.

TABLE XVI.—Holding Power of Railway Spikes in Various Woods (Bevan's).

Wood.	Stress, lbs. Driving.	Pulling.
Beech	6,743	5,978
Ash	5,953	4,560
Elm	4,696	3,690
Maple	3,842	3,111
Green oak	5,820	6,523*
Seasoned oak	6,434	4,241
Chestnut	3,691	3,280
Hemlock	2,106	1,906

* This spike had rusted in the green oak for three weeks.

These results are not at all reliable; probably all were obtained from one isolated trial, and no note is made of the conditions.

Tests were made on nails driven straight, and at various angles, to fasten two blocks together, and then subjected to shear; ⅝-in. slabs were nailed to chestnut with six 6d. nails each.

The shearing stress withstood with nails driven straight was 1,725 lbs., and for the same, nails driven slanting in the direction of the shear it was 910 lbs., and driven slanting opposite to the direction of shear it was 1,400 lbs. It is evident that for hard wood at least, it is better to drive the nails straight. It was found that the fewer the blows struck in driving a nail the greater is its tenacity, and a hand driven nail holds better than a machine-driven one.

Some experiments by Mr. Riddick, of Lehigh University, made in 1890, show the action of cut nails under a dynamic stress. A wooden ram weighing 44 lbs. was let fall on cleats nailed to a large block of wood, and from this the amount of work done in foot-pounds was calculated. He found that 8 to 9 ft.-lbs. of dynamic energy sheared off a block of white pine fastened with one 4d. nail, and with oak wood about 11 ft.-lbs. In hemlock it took about 35 ft.-lbs. of work to destroy a 10d. nail. He concludes with a comparison that a man weighing 150 lbs. dropping 3 ft. would tear loose a plank nailed with thirteen 10d. nails. The same nails, he says, would stand a static pressure of 4,000 lbs. I was unable through lack of time to make such tests, and cannot substantiate these statements. I give below an abstract from his results:

Size of nail.	Kind of wood.	Depth driven.	Work done, ft. lbs.	Result.
6d.	hemlock	½ in.	22	sheared
6d.	oak	½ in.	17.6	"
10d.	hem ock	1 in.	39.6	"

To determine the effect which the time nails remained in the wood before pulling had upon their resistance to a direct pull, nails were driven under as nearly as possible the same conditions and pulled after different lengths of time. Table XVII. shows the results obtained with 20d. nails driven in white pine.

TABLE XVII.—Showing Effect of Time Upon Resistance of 20d. Nails to a Direct Pull.

Kind of wood	Well seasoned white pine.			
Time, days	14	30	60	98
Stress, lbs	525	510	520	490
After being exposed to the weather.	722	566	600	

With nails having plain, barbed and blued surfaces, as before described, driven in hemlock, the results were as given in Table XVIII.

TABLE XVIII.—Showing Effect of Time Upon Resistance to Direct Pull of 6d. Nails Having Different Surfaces.

(Each number is the mean of three tests.)

Time.	Plain. Lbs.	Barbed. Lbs.	Blued. Lbs.	Mean. Lbs.
Directly after driving	325	262	355	314*
Two hours	183	260	470	304
Two days	155	252	425	369
One week	147	205	338	275*

* With oak these figures were 393 and 293 lbs.

These results show nothing more definite than that the tenacity lessens as the nail stands, when the wood is seasoned, and that after weathering the general effect is the same, although shortly after being wet the rusting of the nails causes them to stick better. It is probable that the rusting of the nail does not ordinarily continue sufficiently to seriously weaken the nail, as the cross-section is greater than the mere stress on the nail requires.

It is interesting to note the ratio of the holding power of nails driven into the end of a stick parallel to the grain, to the same when driven perpendicular to the grain; also the relation of these to the tenacity when the nail is driven in the direction of the annular layers of fibers.

Tables XIX. and XX. are compiled from the experiments made at Watertown and given in the report for 1884. No mention was made of the time the nails remained in the wood.

TABLE XIX.—Showing Resistance to Direct Pull of Nails Driven Perpendicular and Parallel to the Grain.

(Each number the mean of five observations.)

Wood.	Stress, lbs. Driven perpen to grain. 8d., cut.	60d., wire.	Driven parallel to grain. 8d., cut.	60d., wire.	Ratio. 8d., cut.	60d., wire.
White pine..	450	167	190	126	2.4	1.3
Yellow pine.	995	318	587	252	1.2	1.3
White oak..	1,340	940	1,106	802	1.3	1.1
Laurel.....	1,179	911	651	518	1.8	1.8
				Means...	1.7	1.4

TABLE XX.—Showing Comparative Resistances of Cut and Wire Nails Driven Perpendicular and Parallel to Grain.

Wood.	Stress, lbs. per sq. in. surface in wood. Cut nail. Perpendicular.	Parallel.	Wire nail. Perpendicular.	Parallel.
White pine....	379	189	167	126
Yellow pine...	602	333	318	252
White oak.....	1,216	1,044	940	802
Chestnut.....	664	...	...	...
Laurel.....	1,179	651	911	518

Roughly speaking, it may be said that a nail holds 1½ times as much when driven in the side of the timber as when driven in the end, i. e., the former is 50% stronger. We may also note from this table that the cut nail is at an extra advantage when driven in the end of the grain.

Any scheme for increasing the surface of a nail, railway spike, or drift bolt is commendable, as it will thereby increase the holding power. Experiments made by Mr. McMynn, of Sibley College, in 1891 on a patent railway spike having its perimeter increased by longitudinal corrugations, showed it to have considerable more holding power than the ordinary spike, as will be seen from the following table:

	Standard.	Patent.	Increase, p c.
White oak	5,830	7,005	20
Hemlock	3,205	3,830	19½

Some cheap modification of the French drive-screw would be an excellent thing, probably, in the form of nails. There should be on no account, however, any sharp angles on the surface. With regard to railway spikes, it is quite possible that in the long run it would pay to use round rods like drift bolts, and drive them into holes bored the proper distance apart beforehand. There is an upper limit to the size of nails that may be used, even in the largest blocks of wood; for the fibers may be so crushed by the wedging of the nail as to entirely destroy their elasticity. This effect is sometimes seen when railway spikes are driven into hard oak, the spike being soon jarred out of place.

Drift Bolts.—Drift bolts as they are commonly used are made both round and square. It was found by Messrs. Tcharner & Powell, of the University of Illinois, that the proper ratio of the diameter of a round drift bolt to the hole in which it is driven was 1 to 13-16, and for the square drift bolt, ratio of width to diameter of hole was 1 to 14-16. It is evident that the square bolt must crush a large part of the fibers with which its surface comes in contact, while the round meets with a uniform pressure all around and need not crush any fibers excessively. We should expect then, the round to be the best shape; and so it is found in experiments made by the gentlemen named above.

Table XXI. shows the results of experiments on the holding power of 1-in. round drift bolts in holes of different diameters in yellow pine.

TABLE XXI.—Showing Effect of Diameter of Holes on Holding Power of Drift Bolts.

(Each number is the mean of three tests.)

Diameter of hole.	Tenacity per 1 in. length in wood. Yellow pine. Round.	Square.	White oak.
12/16	490	600	1,103
13/16	788	675	2,499
14/16	633	777	1,778
15/16	375	740	1,306

The average relative holding powers in yellow pine and white oak were as 1 to 3.1. The diagram, Fig. 10, shows clearly that the best size of hole is 13-16 of the diameter of the bolt. In the same figure is a diagram of the variation of tenacity as a bolt is withdrawn from its hole. It is noticeable that the tenacity falls off very rapidly as the pulling begins, and by the time the bolt is withdrawn 1 in. (1-6 its depth), the tenacity is only 80% its original value. The ratio of holding power of a drift bolt, driven perpendicular to the grain to the same driven along the grain, was oak 1 to 2.4, and for pine 1 to 2.3. The resistance to drawing a drift bolt varies very nearly with the depth to which it is driven.

Conclusions.—There has been very little written on the subject of nails, and still less done in the way of experimental work. Combining the amount of information I have been able to gather from reading, and that obtained from my tests, we may draw the following conclusions:

1. Cut nails are superior to wire nails in all positions.

2. The main advantage of a wire nail is in its possessing a sharp point.

3. If cut nails were pointed their efficiency in direct tension would be increased by about 30%; wire nails without points have but ½ of their ordinary holding power.

4. The tenacity, of wire nails at least, decreases with time, but not so fast, probably, when exposed to the weather.

5. The nail's surface should be very slightly rough, though not granular; should not be galvanized or otherwise made smooth; and should not be barbed; and especially the barbs should not be sharp and angular. Barbing decreases the efficiency of cut nails about 32%.

6. Nails should be wedge-shaped, in both directions where there are not special dangers of splitting.

7. Nails to be used in tension should be about three times the thickness of the thinnest piece nailed, in length, and when used in shear about two times the same. Or the nails should be respectively 160A, and 115A, in length, where A equals area in square inches, of mean section.

8. The relative holding power in the common woods is about as below: White pine, 1; yellow pine, 1.5; white oak, 3; chestnut, 1.6; beech, 3.2; sycamore, 2; elm, 2; basewood, 1.2; laurel, 2.8.

9. The nail usually holds about 50% more when driven perpendicular to grain, than when driven along the grain.

10. The holding power decreases with time.

11. Nails are always strongest when driven perpendicular to the surface of the timber.

12. When subject to impact, nails hold less than 1-12 the strain they can stand when weight is gradually applied.

13. Round drift bolts are superior to square drift bolts.

14. Round drift bolts should be driven in holes 13-16 of their diameter, and square drift bolts 14-16 of the same.

SEWAGE PURIFICATION IN AMERICA.

(Continued from Vol. XXX., p. 477.)

The Enlarged Chemical Precipitation Plant at Worcester, Mass.

The largest chemical precipitation plant and at the same time the largest sewage purification works in operation in this country is located at Worcester, Mass. Improvements and extensions, now nearly completed, possess many interesting and unique features which, with the general plan and mode of

operation of the present works, we are now enabled to describe and illustrate in detail through the courtesy of Mr. F. A. McClure, City Engineer, and Mr. H. P. Eddy, Superintendent of Sewers.*

The system is operated on the continuous plan, using lime and iron salts as precipitants. The iron is derived from the sewage, as described farther on. The lime is stirred in agitators by means of compressed air from one compressor, while a second compressor, at another point, operated by a turbine wheel driven by the purified sewage, lifts the sludge from the ten new tanks to the sludge beds. The turbine wheel is utilized at night to drive a dynamo, by means of which the whole works, or such parts as are desired, may be brilliantly illuminated.

Hourly samples of sewage and effluent are collected for daily analysis in the well equipped laboratory of the works.

Before proceeding to the detailed description of the works a brief review of their history may be given.

Some mode of sewage purification at Worcester was made imperative by an act of the Massachusetts legislature, passed in 1886 at the instance of millowners and others on the Blackstone River. For years the city's sewage had been discharged into the river, through Mill Brook, until, it is reported, it had become so badly polluted as to be offensive at times and to interfere with the use of the stream by certain classes of manufacturers. The city was given four years to construct the works, and on June 25, 1890, just within the limit, the original plant was put into operation, it having been designed and built by Mr. Chas. A. Allen, M. Am. Soc. C. E., then city engineer of Worcester. As first operated the plant treated about 3,000,000 gallons per day, but as high as 6,000,000 gallons were at times treated by it. The balance of the sewage flowed through Mill Brook into the river, the brook having been converted years ago into a main sewer while still carrying the natural drainage of some 12 sq. miles of land. It was finally decided to increase the capacity of the works to 15,000,000 gallons, or more, by adding ten new tanks to the original six, and at the same time to make other improvements. The new tanks were sufficiently completed on July 15, 1893, to permit of use, from which date to Nov. 30, the close of the last fiscal year, the full flow of Mill Brook, sewage and water combined, was treated. The other improvements are now about completed.

The general plan of the works as they now stand is shown by Fig. 86, which includes the tanks and all the buildings. A view of the tanks is shown by Fig. 87. Tanks 1 to 6 are the old and tanks 7 to 16 the new part of the plant.

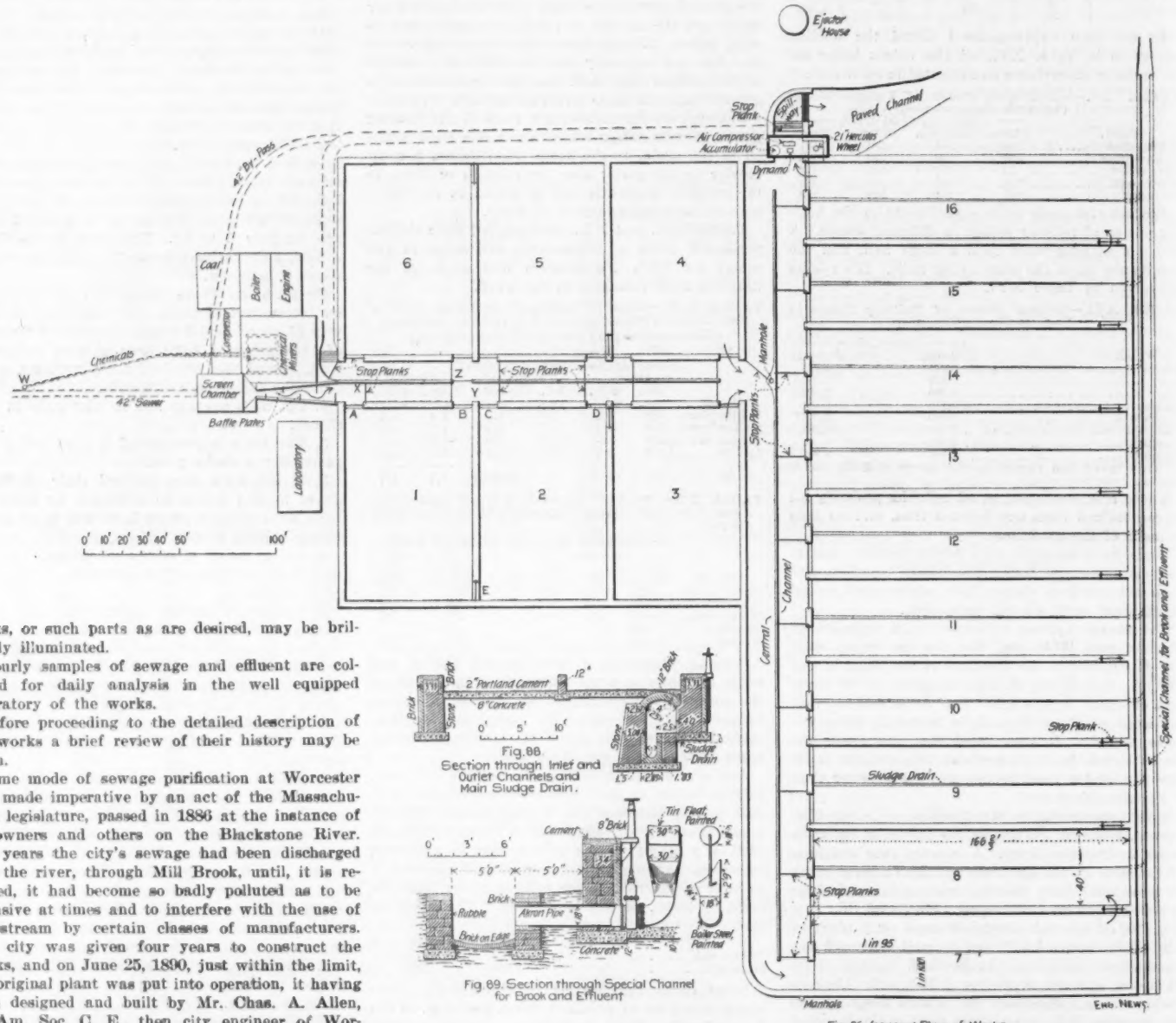
Each of the ten new tanks is $40 \times 166\frac{2}{3}$ ft., $\times 5$ ft. deep below the floor of the inlet channel. Their area is the same as the old tanks, but the latter are more nearly square, being $66\frac{2}{3} \times 100$ ft. The combined storage capacity of the old and new tanks at the depth usually flowed is 5,000,000 gallons.

The construction of the new tanks is described by Mr. McClure as follows:*

Immediately following the order passed by the city council, May 13, 1892, preparations were made to excavate the mud of the swamp in which the new work was located. The material being saturated with water, a submerged pump well was sunk in a convenient position, with discharge boxes leading from it to distant parts of the field, the excavation being of such an unstable nature that an agitation with spades allowed it to flow to the pump, and considerable quantities were removed in this manner. As the water table lowered and the fibrous nature of the mire obstructed this process, several ditches were dug, radiating from the well through which the water was conveyed, and in a short time the mud was sufficiently compact to allow of removal in ordinary ways. Its depth varied from 3 to 9 ft., with a substratum of very hard compact gravel. With the completion of the excavation, the brook which enters the southwest corner of the locaton was turned into the pit and made use of to puddle the sand and gravel constituting the fill. Each successive layer was well puddled by, this means, and as the upper portions were reached further compact was made by a heavy grooved roller in addition to the carts running over it. The embankment has proved to be firm, without the least indication of settlement. As soon as the fill reached the proper height forms were laid, within which the concrete foundations were placed, consisting of five parts screened gravel, two parts sand and one part Rosendale cement. Its thickness is 12 ins., and the width was carried 6 ins. beyond the finish lines of the walls. Upon this foundation was first placed a rubble wall of hand stone 2 ft. in thickness, carefully laid in cement mortar and then faced with selected brick 8 ins. in thickness. After a sufficient length of wall was constructed the coping was then made by placing adjustable wooden molds in position, partially filling them with Portland cement mortar and inserting quarry chips to within about 2 ins. of the top, which was then finished by floating the mortar to the top of the molds. For this purpose this form of construction has proved satisfactory from its neatness of appearance, strength and economy; the walls are watertight and possess that very essential feature of being easily kept clean.

The floor of the basins is composed of Rosendale cement concrete, made in proportion of four parts of screened gravel, two parts sand and one part of cement and is 10 ins. in thickness.

The inlet and outlet channels and the sludge drain for the new tanks are shown in section by Fig. 88, while Fig. 89 is a section through the chan-



FIGS. 86, 88 AND 89. GENERAL PLAN AND SECTIONS OF ENLARGED CHEMICAL PRECIPITATION PLANT AT WORCESTER, MASS.

*The original works were described and illustrated in Eng. News, of Nov. 15 and 22, 1890. Additional details regarding the operation of the works and a brief outline of the extensions and improvements now fully described were given in Eng. News of July 28, 1892.

* The quotations in this article, with the exception noted, and much of the other information regarding the new tanks is from City Engineer McClure's annual report for 1892-3, submitted to the city council recently, but not yet printed.

nel for the brook at the south end of the new tanks, into which empty the pipes for drawing down the basins to the sludge level for cleaning. These features are described by Mr. McClure as follows:

This conduit (Fig. 88) through which the sewage is conveyed to and from the basins is 15 ft. wide, with connecting weirs to the different basins of the same width. The inflow and outflow channels are divided by a 12-in. wall of brick capped similarly to the basins. Beneath the conduit is an arched subway containing the main sludge drain, access to which is obtained through an extension of the pipe arch to the old basins, and also from manholes that serve the double purpose of entrance and ventilation. The subway subjoins the wall of the basins, and is inclosed by a wall of rubble masonry laid upon a foundation of Rosendale cement concrete 12 ins. in thickness. It is arched with three courses of brick, and in addition to the 18-in. sludge drain contains a footwalk 30 ins. in width to admit of cleaning and inspection of the entire drain with its connections. The drain has a fall of 1 ft. in 145, with sidewalls and invert of brick 8 ins. in thickness, and opposite the center of the several basins connection with them is made by piercing the walls with a 12-in. brick drain controlled by a sludge gate placed within the basins.

Through the center of the basins in their greatest length a sludge drain is formed in the concrete floor, with a descending grade toward the main drain 1 ft. in 95 and the floor from the sides of the basins slopes toward this central drain with a fall of 1 ft. in 100.

Above the arch the space to subgrade of the conduit was filled with gravel and puddled, upon which a bed of Rosendale cement concrete was placed 8 ins. in thickness and finished with Portland cement mortar. The (sewage) conduit is level throughout its length with a return channel to the old basis to provide for a change in manipulation, if desired.

A continuation of the conduit (or central channel) past the discharge from the last basin brings this channel to the spillway, which consists of two series of cut stone steps (see the views, Figs. 91 and 92), with a quarter circle landing, paved with selected granite street blocks laid in Portland cement mortar. Adjoining the lower series of steps to the spillway is the embouchure of the by-pass through which the sewage may be diverted around the entire plant. The effluent being of such volume design was made to utilize it, and in the angles of the basins and spillway was placed a penstock 7½ ft. square containing a 21-in. Hercules turbine wheel, through which the effluent is passed from two weirs 7½ ft. in width, one leading from the last basin and the other from the central channel.

Along the southerly side of the basins a special channel (Fig. 89) was constructed for the brook above mentioned and an emptying pipe from the basins connecting with it, which allows one or any number of the basins to be cleared at once whenever it is desired to draw off the clarified sewage for cleaning purposes. The channel is 5 ft. in width and built of rubble masonry laid in cement mortar with an invert of brick on edge. The discharge pipes are 18-in. round Akron, laid straight through the walls and ending with two lengths of curved pipe to take the direction of the wasteway and finished through the channel walls with brickwork. They are controlled by 18-in. Chapman valves placed within the basins, with stem leading to a standard supported on a wallbracket. On the basin side of the valve is a movable pipe working vertically and parallel to the adjoining wall of the basin. This is supported by a cylindrical float so arranged that its connecting arms can be adjusted to facilitate drawing the sewage to the lowest possible limit without disturbing the sludge deposit.

The old chemical mixers, with their revolving wooden arms, were taken out and in their place two iron mixing tanks were provided, each 8×16 ft. ×8½ ft. deep, supported by brick masonry, as shown in Fig. 90. The lime, which, aside from the iron in the sewage, is the only chemical now used, is discharged into the mixers from the floor above and is agitated by means of compressed air discharged through the perforated pipes shown in Fig. 90.

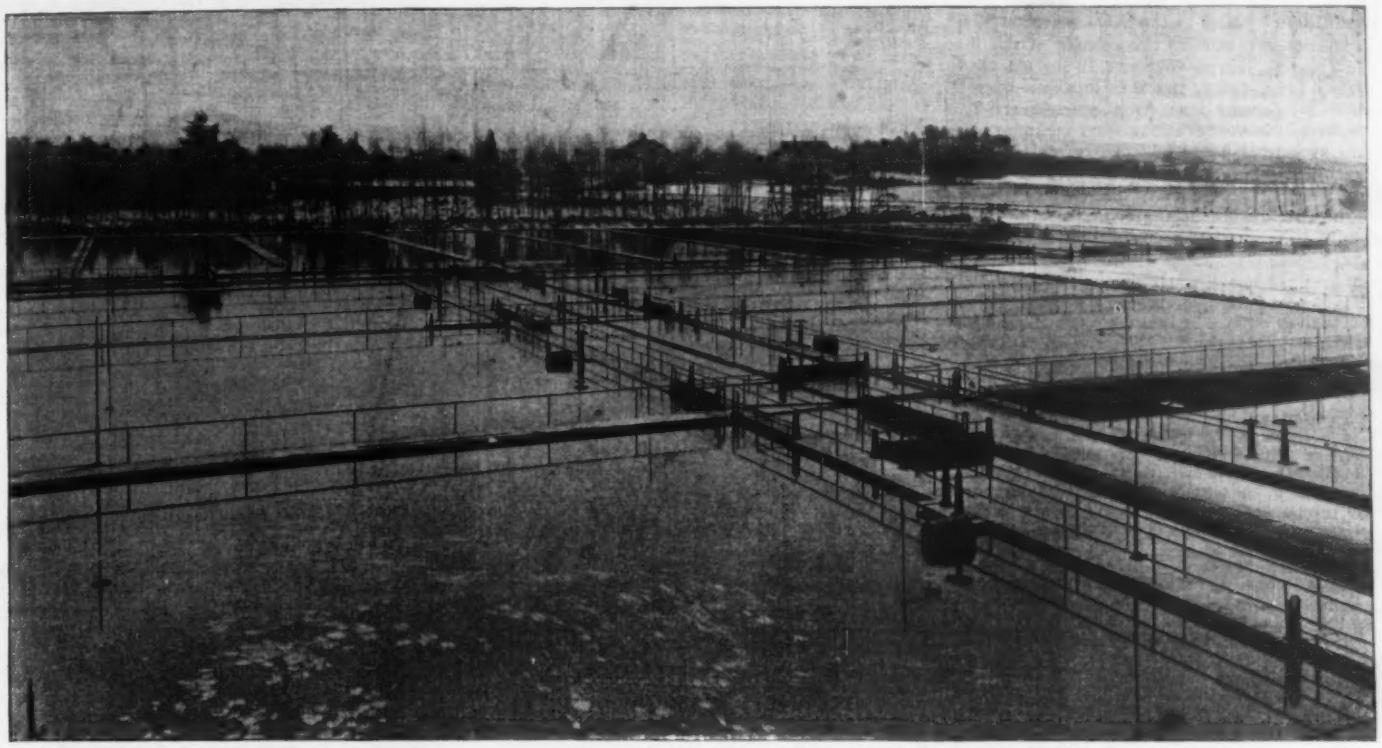


FIG. 87. GENERAL VIEW OF PRECIPITATION TANKS.

Air is compressed by a horizontal duplex Rand compressor (Class B.), which was in the possession of the sewer department. An accumulator 5 ft. in diameter and 10 ft. in length is used, and from this a 4-in. air supply pipe leads to the mixing

FIG. 91. VIEW OF EFFLUENT SPILLWAY, TURBINE AND EJECTOR HOUSES.

Before considering the removal and disposition of the sludge it will be well to take up the manipulation of the chemicals and the course of the sewage through the works. With the remodeling of the plant many changes and enlargements were made inside the buildings, chief among which are the new chemical mixers, which have a combined capacity of five tons of lime or other precipitant. tanks. From each of the mixing tanks a 6-in. chemical discharge pipe leads to the manhole, Fig. 86, from which point a single pipe extends to the 42-in. sewer from Mill Brook, terminating at the point W.

Formerly the chemicals were admitted to the sewage between the screen chamber and the baffle plates, shown in the plan, Fig. 86. Thus the lime

and sewage have a longer flow before reaching the settling tanks, insuring a more satisfactory mixing prior to precipitation than was given with the old point of discharge.

When there were but six tanks the sewage passed through them in the order of their numbering, Fig. 86. The sewage is now divided at Z, Fig. 86, thus reversing the flow through tanks 6, 5 and 4. As the sewage comes from tanks 3 and 4 it unites and passes to the new influent channel. This division also reduces the velocity of the sewage, increasing the precipitation in the old tanks.

As has been stated, the iron in the sewage is used to supplement lime as a precipitant. This iron comes in large quantities from manufacturing wastes at certain hours of the day and is stored for use in the intervals. The method of storing the iron and of subsequently distributing it is described below by Mr. McClure, the description being from a recent letter for use in this connection, as follows:

When the iron appears it is stored in tanks 1 and 2, to be used as required. We will suppose that the basins are full of iron in the process of being added to the sewage. In the conduit between X and Y there is a fall of 1 ft., which creates considerable velocity and agitation, and entering at weir C forces the iron out of weirs E and A into the sewage, after which, as you will observe by the direction lines, a portion is diverted into basins 6, 5, 4 and 3, where the heavier portion of the precipitation takes place, and finally joins, as it emerges from tanks 3 and 4, taking the new conduit, to the additional tanks for further precipitation. The iron being used in tank 2 the sewage is turned into tank 1 through weir B, forcing the iron out of weir A as before. The lime is added continuously to the sewage at W in amount as required, which is determined by testing with phenophthaleine. The tests are constantly being made by an attendant, in the conduit and several tanks, for which purpose the electric lights were added for night work.

Figs. 91 and 92 are views from photographs showing the turbine and ejector houses, the spillway for the effluent and the arched subway, from which the sewage debouches when it is passed around

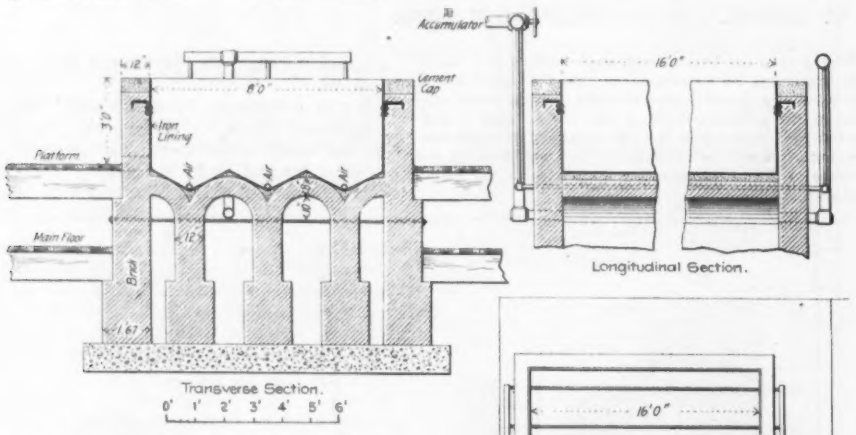


FIG. 90. PLAN AND SECTIONS OF CHEMICAL MIXERS.

the works without treatment. In the background of Fig. 92 may be seen the main buildings connected with the works, that on the left being the laboratory.

Further details of construction and operation will be given in another issue. Regarding the capacity and general operation of the plant, Mr. McClure makes the following statement in his forthcoming report:

While the plant is nominally capable of treating 15,000,000 gallons in 24 hours, experiments have shown that very good results can be obtained with a considerably larger amount, which fact enables the disposal of all flushings from the advent of storm water and to a point in flood discharge where the sewage will be in such a state of dilution that the escape of small quantities should have no deleterious effect upon the river. The difficulties of successfully treating a sewage containing all the manufacturing wastes of diversified industries are greatly enhanced by its variable conditions, the working hours especially being subject to continuous deviation, both in quantity and quality, and requiring never ceasing watchfulness with proper tests to produce the desired results. No fast rules for treatment are capable of application in dealing with such transient conditions as are here experienced, and only by variable treatment as the sewage requires can a successful issue be reached.

PERSONALS.

Mr. George A. King has been elected City Engineer of Taunton, Mass.

Mr. Edward B. Codwise has been re-elected City Engineer of Kingston, N. Y.

FIG. 92 VIEW OF TURBINE AND EJECTOR HOUSES, WITH THE OTHER BUILDINGS IN THE DISTANCE.

Mr. Jas. T. Taylor, of Riverside, Cal., has resigned his position as engineer of the Riverside Construction Co.

Mr. Louis L. Tribus, Assoc. M. Am. Soc. C. E., has opened an office for special practice in waterworks and sewerage at 84 Warren St., New York.

Mr. Isaac T. Van Duzer, railway contractor, died in St. Paul, Minn., Jan. 5, at the age of 77. He built the Hudson River R. R. between Poughkeepsie and New York.

Mr. L. Wildeson has been appointed Roadmaster of the Western Division of the Wheeling & Lake Erie Ry., with headquarters at Norwalk, O., vice Mr. D. McEntaffer, resigned.

Mr. Charles S. Larrabee, President of the Larrabee Iron & Machine Works, of Bath, Me., died Jan. 2 at the Indian Head proving grounds, on the Potomac River, near Washington. He recently invented a fuse for naval purposes and his visit there was to have experiments made with the fuse.

Mr. G. L. White has been appointed Roadmaster of the Eastern Division of the Wheeling & Lake Erie Ry., with headquarters at Massillon, O., vice Mr. L. Wildeson, transferred.

Mr. E. B. Wall, Assistant to the President of the Pennsylvania lines, has been transferred from Chicago to Pittsburg, and appointed Assistant to the General Manager, with general oversight of the purchasing department.

Mr. J. M. Edwards, Third Vice-President of the Yazoo & Mississippi Valley R. R. and Acting General Manager of the road under the Illinois Central R. R. ownership, has resigned to take a position with R. T. Wilson & Co., the New York bankers. He will look after the railway interests of the firm.

Mr. C. C. Martin, Chief Engineer and Superintendent of the Brooklyn Bridge, began, on Jan. 3, the twenty-fifth year of his continuous service on that structure. He was appointed First Assistant Engineer to Mr. Roebling on Jan. 3, 1876, having previously been Chief Engineer of Prospect Park, in Brooklyn. This is a record of continuous engineering service upon one and the same piece of work rarely met with in these times.

Mr. J. B. Klinke, who was specially delegated by the German Minister of Railways to study and report upon American railways, has now been three months in this country and has inspected many roads and railway shops. He is credited with the statement that German track and German stations are somewhat better than ours; but that in the excellence and convenience of our cars we excel the world. Our railway shops are also better, he says, and they are wonderfully well equipped for doing the best class of work. "There is nothing like them in Germany."

Mr. Voorhees, General Manager of the Lehigh Valley R. R., has announced the following changes in the operating department: Mr. Charles A. Beach is appointed Superintendent of the Buffalo Division. Mr. J. N. King is appointed Superintendent of the Seneca Division. Mr. Alexander Mitchell is appointed Superintendent of the Wyoming Division, vice Mr. O. O. Esser, assigned to other duties. Mr. T. H. Fennell having resigned, the office of general superintendent of the Northern Division will for the present remain vacant. The office of the superintendent of motive power and rolling stock will be discontinued.

NEW PUBLICATIONS.

JANUARY MAGAZINES.—"Scribner's" has a well illustrated article, which should interest architects, entitled "Stories in Stone from Notre Dame," describing the sculpture which adorns the great Paris cathedral. In "Harper's," Edwin Lord Weeks continues his account of Persian travel, and Richard Harding Davis describes life in London at each end of the social scale. There is also a sensible paper on the "Bread and Butter Question," a problem which seems to confront the world more sternly than ever as this year of grace 1894 opens. "The Century" has a graphic description of the lighthouse on Minot's Ledge on the south side of Boston Bay, and the life that its keepers live. Another article in this number is an account of the first use of chloroform as an anaesthetic by the daughter of Sir Jas. Simpson, who was the discoverer of its anaesthetic properties.

The "North American Review" has a good assortment of timely political articles as usual, and Rear Admiral Ammen, U. S. N., discusses the question whether the value of our fast cruisers is overestimated. He holds that in the event of a war with England

our much prized "commerce destroyers" could inflict very little damage on the enemy's merchant vessels, but wisely declares that England's maritime supremacy is really a guarantee of peace, and not by any means a thing at which we need turn jealous or fearful. He closes with an expression concerning the real unity of English speaking peoples, a unity which was recently discussed in a magazine article by Mr. Andrew Carnegie, who prophesied therein its probable eventual result in a political unity of English-speaking peoples. A similar idea was expressed by Mr. W. T. Stead, editor of the "Review of Reviews," in an address recently delivered at Toronto and reprinted in the current number of that magazine. The most valuable paper in the number, however, is a description of the methods which have been put in force for the relief of the unemployed this winter in 14 principal cities of the United States.

In the "Popular Science Monthly" Prof. Jas. L. Greenleaf, Professor of Civil Engineering in Columbia College, writes on "Window Lights and Their Value," a paper which contains much of interest and practical value. Mr. L. C. Loomis has a paper on "Recent Railroad Disasters," in which he demonstrates to his own complete satisfaction that the cause of these disasters is not defective methods or mechanism—not at all: the fault is in the men. He thinks the responsibilities of the modern railroad employee are so great that they should be divided and there should be two conductors, two rear brakemen, two engineers, etc. Thus he naively remarks:

> Does any one for a moment suppose that if there had been a second officer whose business it was to inspect that Wabash switch and see and certify that it was properly set, or that if the Yonkers brakeman had been followed by a second signal light 50 yds. in the rear, either of those catastrophes would have occurred, or any of those recent rear-end and siding calamities?

We respectfully commend Mr. Loomis' plan to those railway managers who insist that the old methods and appliances are good enough and that the men are the sole ones in whom the fault lies. One is tempted to question, however, how long it would take to move traffic if an inspecting officer had to examine each switch and file a certificate of its position every time it was open or closed. Apparently Mr. Loomis' genius does not lie in the direction of railway management. Other articles in this magazine which deserve mention are brief descriptions of modern deep-sea sounding and the U. S. Life Saving Service, and a paper on "Inventions and Industry at the South."

REPORT OF THE INTERSTATE COMMERCE COMMISSION for 1893. Pub. Doc.; 8vo; paper; pp. 226.

The bulk of this, the seventh annual report of the commission, is, like previous reports, taken up with the general review of the proceedings and decisions of the year and a somewhat extended discussion and statement of amendments to the law which are recommended. These now number seven specific amendments, besides a general recommendation to review and discuss the law in respect to its revision to accord more with recent developments in the railway business. The specific amendments recommended are:

1. An amendment in respect to proceedings to enforce the lawful orders of the Commission, as suggested in former reports.
2. That the word "line," when used in the act, shall be construed to be a physical line, not a business arrangement, and the words "any common carrier," as used in the act, shall be construed to mean one or more than one carrier, as the case may be.
3. That section three of the act be amended by providing a procedure for the establishment of through routes and joint through rates.
4. That power be conferred on the Commission to prescribe minimum as well as maximum rates to competitive points.
5. That provision be made for the adoption of a uniform classification of freight.
6. That corporations subject to the act be made subject to indictment for prohibitive acts.
7. That the 20th section of the act be amended by fixing the time within which companies subject to the act shall make reports, and fixing a penalty for failure to report within the time prescribed, and providing for the enforcement and collection of such penalties.

A brief review of the report was given in our issue of Dec. 14, 1893.

ALBUM DE LOS FERROCARRILES CORRESPONDENTE AL ANO DE 1891. Mexico. 8vo; pub. doc.; pp. 438.

This very complete publication contains all the usual features of official railway reports, and in addition the freight classifications and the concession and other laws relating to each Mexican company, of which there are now a good many, though only four are of any great magnitude in respect to miles of track.

HOW TO WIRE BUILDINGS.—A Manual of the Art of Interior Wiring. By Augustus Noll, E. E., Member Am. Inst. Elec. Engineers. New York: C. C. Shelley; 8vo; 162 pp.; many illustrations.

The use of the electric current for all manner of purposes and in almost every variety of structure makes it very important, to both the consumer and to installing companies, that the wiring should be done in a proper and workmanlike manner. In this book Mr. Noll plainly details his own personal experience in work of this character and says that no rule or advice is given that has not been tested by actual trial and observation. In his text technical expressions, at least of an abstruse nature, are carefully avoided, and by plain words and clearly drawn diagrams he seeks to explain so that beginners may understand. The subject matter is treated under 27 chapter heads, dealing with the numerous problems likely to arise and with the generation of power, testing, etc.

THE MEMPHIS SYSTEM OF SEWERAGE AT MEMPHIS AND ELSEWHERE.—By Geo. E. Waring, Jr., M. Inst. C. E. Presented at the Twentieth Annual Meeting of the American Public Health Association, Held in the City of Mexico. Reprinted from Vol. XVIII. of the Transactions of the Association. Pamph., pp. 18.

This paper sketches briefly the history of the Memphis sewerage system and includes letters regarding stoppages in the sewers of some 20 towns where small pipes have been used.

SOCIETY PROCEEDINGS.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.—The annual meeting will be held at Cleveland, Jan. 16 to 19.

WESTERN SOCIETY OF ENGINEERS.—The annual meeting and banquet were held at Chicago, Jan. 3, and the following officers were elected: President, Hiero B. Herr; Secretary, Thomas Appleton. Addresses were made by the retiring president, Capt. Robt. W. Hunt, Mr. E. L. Corthell, Mr. L. E. Cooley and others. Mr. Herr, in his address, spoke on the question of reorganizing the society and establishing in Chicago a society on such a basis as would make it the national society..

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting on Jan. 3 a paper was presented by Mr. Theodore Cooper, on "Train Loading for Bridges." The annual meeting will be held on Jan. 17, beginning at 10 a. m. The annual report of the Board of Direction and reports from special committees will be presented. An amendment to the constitution will be considered, and the ballot for officers of the society for the ensuing year will be canvassed. In the evening a paper on "Cableways," illustrated by lantern slides, will be presented by Mr. Spencer Miller. Arrangements for the entertainment of the members on Jan. 18 are in progress.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the meeting on Dec. 19 the following officers were nominated for the ensuing year: President, Chas. Davis; Vice-President, W. G. Wilkins; Secretary, Daniel Carhart; Treasurer, A. E. Frost. Members of Board of Directors, Julian Kennedy, Thos. P. Roberts. A paper was read by Mr. Roberts, describing a proposed method of increasing the navigable depth of the upper Ohio River by storing water in reservoirs on its headwaters and letting it out to raise the level of the river at medium stages. The paper was discussed by Messrs. M. J. Becker, W. L. Scaife, G. Kaufman, Thos. H. Johnson and W. C. Wilkins.

The Chemical Section held a meeting on Dec. 26, at which the following nominations were made: Chairman, Karl F. Stahl; Vice-Chairman, Jas. F. Camp; Secretary, Abram T. Eastwick; Additional Directors, F. C. Phillips and Jas. O. Handy. Mr. Handy read a paper on "The Exact Determination of Phosphorus by a Molybdate Method when Arsenic is present in Iron, Steel and Ores."

MICHIGAN ENGINEERING SOCIETY.—The fifteenth annual convention was held in the council rooms at Jackson, Mich., Jan. 2, 3 and 4. Papers were read as follows: "Surveying in Tennessee," D. Streets; "Ice Surveys and a Machine for Cutting Holes in Ice," Joseph Ripley; "Lumbering in Northern Michigan," F. S. Dewey; "Ways and Means for Road Improvement," J. J. Watkins; "A Swim for Life," W. L. Coffinberry; "A Road Case in the Courts," M. H. Bailey; "Methods of Irrigation," A. L. Reed; "Manufacture, Use and Tests of Wooden Pipe," G. L. Wells; "Methods of Quarrying," H. G. Rothwell; "The Michigan and Ohio Boundary," James Blair; "The New York Boundary Surveys," J. B. Davis; "Reclamation of Swamp Lands," O. H. Todd; "Franklin St. Bridge, Lansing," E. Sellers; "Purity of Water Supply," W. R. Coats.

The annual report of the secretary and treasurer showed the society to be in a sound condition financially. Among the nominations for officers to be elected by letter ballot were Geo. L. Wells and Geo. S. Pierson for President, and F. Hodgman for Secretary and Treasurer.

ENGINEERS' CLUB OF PHILADELPHIA.—Meeting of Dec. 16. President, John Birkinbine in the chair. After the conduct of regular business Mr. Birkinbine exhibited a hemisphere of metallic ore highly polished and with a ⅝-in. hole drilled slantingly through its upper part, and stated that, while traveling in Mexico, a companion, having promised to get him a meteorite, upon reaching Pueblo, had presented him with this specimen. The donor believed it to have been a very old mirror, but the holes seemed to be too small to have served for finger places. It was extremely hard, being capable of scratching glass, and to get some particles for analysis, it had taken three-quarters of an hour to drill a very shallow hole in it; how long, then, must it have required to drill a hole 1¾ in. long through the material? Mr. E. K. Landis, who had analyzed these borings, had found that the specimen was an iron pyrites, with about 43% each of sulphur and iron, with the other ingredients still to be analyzed. Mr. A. Falkenau described the 40-in. Yerkes telescope, the tube of which is 42 ins. in diameter at the objective end, 52 ins. at the center and 38 ins. at the eye-end. The sheet steel forming the tube varies from 7-32 in. in thickness at the center to ⅛ in. at the ends. The total weight of the tube is 6 tons. The declination axis carrying the tube is of forged steel 12 ins. in diameter and 12 ft. long, its weight being 1¼ tons. This runs in segmental Babbitt bearings in the declination sleeve, which weighs 4 tons. The polar axis carrying the whole system is of hard forged steel, 15 ins. in diameter at the upper bearing and 12 ins. at the lower bearing and weighs 3½ tons. Just above its upper bearings it carries the main driving gear weighing one ton and having 360 teeth, by which the movement of the driving clock is communicated to the polar axis. The method of sustaining the great weight of the bearings and overcoming friction by means of steel rolls and the methods of balancing the movable parts were described in detail. The column supporting the instrument is 11 ft. × 5 ft. at the base, tapering to 10 ft. × 5 ft. at the top, and is cast in five sections, bolted together by internal flanges.

L. F. Rondinella, Secretary.

COMING TECHNICAL MEETINGS.

ENGINEERS' SOC. OF WESTERN PENNSYLVANIA.
Jan. 16. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Jan. 16. Secy., Clement F. Street, Rookery, Chicago.
COLUMBIAN ENGINEERING SOCIETY
Jan. 16. Secy., F. W. Hart, Washington, D. C.
OHIO SOC. OF SURVEYORS AND CIVIL ENGINEERS.
Jan. 16-19. Annual Meeting, Cleveland, O. Secy., Chas. A. Judson, Sandusky.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Jan. 17. Secy., L. J. Carmalt, Roanoke, Va.
ENGINEERS' CLUB OF ST. LOUIS.
Jan. 17. Secy., Arthur Thacher, Odd Fellows' Bldg.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17, 18. Annual meeting. Secy., F. Collingwood, 127 East 23d St., New York.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 18. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
Jan. 18. J. F. Wilson, 24 W. 4th St.
NEW YORK RAILROAD CLUB.
Jan. 18. Annual meeting. Secy., John A. Hill, Temple Court.
SCANDINAVIAN ENGINEERING SOC. OF CHICAGO.
Jan. 18. Secy., Howard Berge, 100 Washington St.
SOUTHERN & SOUTHWESTERN RAILWAY CLUB.
Jan. 18. Secy., S. A. Charpior, Macon, Ga.
TACOMA SOC. OF ENGINEERS AND ARCHITECTS.
Jan. 19. 201 Washington Building.
ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 20. Secy., L. F. Rondinella, 1122 Girard St.
SWEDISH ENGINEERS' CLUB.
Jan. 20. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
CENTRAL RAILWAY CLUB.
Jan. 24. Secy., S. W. Spear, Buffalo, N. Y.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 24. Secy., S. E. Tinkham, 36 Bromfield St.
ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 1. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Feb. 2. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Feb. 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 5. Secy., C. L. Annan, City Engineer's Office.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Feb. 6 Secy., W. Halliburton.
WESTERN SOCIETY OF ENGINEERS.
Feb. 7. Secy., J. W. Weston, Lakeside Bldg., Chicago.
ENGINEERING ASSOCIATION OF THE SOUTH.
Feb. 8. Secy., Hunter McDonald, Nashville, Tenn.
ENGINEERS' AND ARCH'TS CLUB OF LOUISVILLE.
Feb. 8. Secy., F. W. Mowbray, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASS'N.
Feb. 9. Secy., D. W. Meeker, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Feb. 10. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
Feb. 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
Feb. 12. Secy., M. F. Schinke, City Hall, Milwaukee.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 12, 13. Virginia Beach, Va. Secy., R. W. Raymond, 13 Burling Slip, New York.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 13. Secy., F. C. Osborn, Case Library Building.
NORTHWEST RAILROAD CLUB.
Feb. 13. Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Feb. 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF CIVIL ENGINEERS.
Feb. 13. Secy., F. E. King, Jacobson Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Feb. 14. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Feb. 14. Secy., F. M. Curtis, P. O. Box 1576, Boston.
AMERICAN RAILWAY ASSOCIATION.
April 11. Secy., W. F. Allen, 24 Park Place, New York.
AMERICAN SOC. OF MECHANICAL ENGINEERS.
May —. Secy., F. R. Hutton, 12 W. 31st St., New York.
MASTER CAR BUILDERS' ASSOCIATION.
June 12, 16. Saratoga, N. Y. Secy., J. W. Cloud, Rookery Building, Chicago.
AMERICAN ASSOC'N OF MASTER MECHANICS.
June 19, 23. Saratoga, N. Y. Secy., Angus Sinclair, Temple Court, New York.

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The Chicago "Tribune" of Jan. 1 devotes a page to real estate transactions in that city and illustrates a number of the "sky-scrapers" erected in that city within the last few years, buildings ranging from 9 to 15 stories in height. As showing the wonderful advance in real estate values in Chicago, mention is made of a lot on the corner of State and Washington Sts., a little over 90 ft. square, that was bought in 1844 for $500. The heirs to this property have lately leased it on terms which place its value at $1,050,000 in 1896, and $1,400,000 in 1906. Another corner near by was leased in 1889 at a value of $500,000, and in 1893 was sublet on terms fixing its value at $800,000. As a result of these high prices for land, and to permit the construction of buildings large and high enough to provide for adequate returns on the outlay required, the tendency of the market is toward a combination of holdings and purchase by syndicates. Leases of 99 years at fixed rentals are also common, and the 90-ft. lot above mentioned has been so leased for $75,000 per annum. According to the transfer lists the recorded sales of real estate in Chicago rose from about $87,000,000 in 1886 to nearly $246,000,000 in 1890, and were over $133,000,000 in 1893. For a city that 50 years ago had barely 5,000 inhabitants and was almost completely burned down about 20 years ago, this is doing very well.

The late report of the Ohio Road Commission furnishes some food for discussion upon the subject of good roads. The cost of improving all the roads of the state is figured at the prohibitive sum of $400,000,000; though in making this estimate an average cost of $5,000 per mile is used, which is much too large when applied to 80,000 miles of roads of all classes in one state. The commission goes on, however, to state that when a really good road is in question it costs little, if any, more to lay down a line of steel rails on a country road than it does to improve the whole road according to modern requirements. "Over this road not only wagons and carriages propelled by horses, but cars propelled by electric power might also go at a greatly reduced cost in transportation." The commission compares the cost of transportation by horses over the average road and by steam over railways as 25 cts. is to about ½ ct. per ton-mile, and it believes that even with all the unavoidable inconveniences of the common use of the rails and turnouts the ultimate cost of the proposed system of transport would be very much less than with horses on the best of roads.

As to the relative tractive force required, the advantage is undoubtedly in favor of the steel rail, as compared with the best macadamized road, and the average cost of maintenance is also probably much in favor of the steel roadbed. The difficulty would come in the cost and in regulating the common use of these rails for traffic and in making a single line of rails, as a rule, serve the traffic in both directions. The State of Ohio covers nearly 40,000 sq. miles, and with main roads laid out three miles apart each way about 25,000 miles of main highways would be required. A fairly good single-track line, laid with 45-lb. rails, would cost about $5,000 per mile, and the entire system would cost $125,000,000, without estimating for the double line of rails needed at many points. While the sum thus required would probably be about one-half of the commission's estimate for the general improvement of all roads in the state, this is still a very large sum of money to be devoted to this purpose, especially if it is to be raised without state aid. Before anything can be done in this direction the relative cost will have to be much more closely studied than seems to have been done by the Ohio State Commission, both as to first cost and as to maintenance of way. The commission seems to base its recommendation of steel railways upon General Gilmore's statement that the relative tractive force upon steel rails and upon a macadamized road is as 1 is to 8. But any practicable system of steel highways would be very different from the line of steel rails upon which General Gilmore bases his comparison, and the mud and dust encountered and the lack of rigidity in the roadbed would seriously reduce the estimate of comparative tractive force required on steel or macadamized roads of equal cost.

It looks very much as of the Ohio Highway Commission had somewhat misinterpreted the purpose for which it was created and had jumped to a conclusion, as to the superior merit and economy of lines of steel rails, based upon a false premise of the ultimate cost of highway improvement in that state. It is not to be supposed that the 80,000 miles of roads of all classes in Ohio are to be at once improved and the estimate of an average cost of $5,000 per mile for all roads is altogether too high. It is only just, however, to the Ohio commission to say that the cost of highway improvement in any state and the methods of construction to be recommended depend upon the careful collation of facts and study of conditions, which this commission, as a temporary body, did not have the opportunity to investigate and report upon. Among these features are the relative ability of the citizens to pay for improvement, the importance of the roads to be improved, the character of the traffic and the soil and the roadmaking material available in the several parts of the state. To study these conditions carefully and to report upon them intelligently require a permanent organization and a competent staff backed by an adequate state appropriation; and so far Massachusetts is the only state in the Union which has seen the wisdom of this course. As to the recommendation that lines of steel rails on the highways open to common traffic would be more economical than the general improvement of the highways, it can only be said that there doubtless would be an economy in tractive force required and probably some economy in maintenance. But as a substitute for highways, any well laid and sufficient system of steel rails would be again prohibitive in cost; and unless rails on main highways were paralleled and fed laterally by improved roads, there would be little, if any, substantial gain to the common user.

We do believe, however, that, especially in the neighborhood of large towns and cities, the present rapid extension of suburban electric railways will in itself hasten the general improvement of all roads affected by them. These suburban lines, by connecting chains of villages and towns and increasing the facilities for travel, tend to enhance the value of country property as a place of residence, and as a consequence create a demand for better roads and make it easier to meet the cost of improvement. Though of very recent introduction, the electric railways of the United States now aggregate 7,500 miles of single-track, and numberless projects now only await better times to immeasurably increase this mileage by the construction of long suburban lines. Though the trolley system was originally intended as a substitute for horse traffic on city railways, and it is extensively used for this purpose, there is little doubt but that its great growth in the future will be in the direction of suburban lines. It is a comparatively cheap system of transport and a speed of 30 miles per hour can easily be maintained on open roads free from crowds, and the present objections to its use in cities do not hold as applied to country operation. The one thing yet needed in these suburban roads is some method of transporting light freight or express matter. As we understand it the lack of such service on existing lines is due to the lack of chartered rights; the influence of other lines of transportation being yet sufficiently great to limit the rights of electric lines to the transport of passengers only. As applied to cities this limitation is proper enough; but the usefulness of suburban lines would be greatly increased if the passenger could send his trunk, his marketing, or any other light freight to his country home by the same line which carries him. This will doubtless come in time as roads of this character multiply and their influence becomes greater.

The standardized screw method of measuring the speed of a vessel has been recommended for adoption in place of the present run over a measured 40-mile course by a board made up of chiefs of bureaus of the Navy Department, and its adoption is favored by Chief Engineer Melville, as stated in his paper published in our issue of Nov. 30. The expense to both the government and the contractor of testing a ship on the measured mile is very great. Vessels must be stationed all along the course to take tide and current observations, and the contractor must keep his trial crew under pay for some time while preparations are in progress and also after the trial until all the corrections can be computed and it can be known whether a second trial must be made.

By the standardized screw method the vessel is run over a measured mile course at various speeds to determine the relation between the number of revolutions of the propeller and the speed of the ship through the water. With this information obtained, the vessel can be put through her paces anywhere and the aid of a good-sized fleet is not necessary to running a speed trial.

It is worth while pointing out in this connection the fact that such a thing as a reliable and accurate speed recorder for indicating the velocity of a vessel through the water appears to be as yet unknown. The patent taffrail logs which have generally displaced the old-fashioned log line on steamers, are wholly unreliable where speed is to be measured with high accuracy. On the "Columbia's" speed trial the patent log recorded a speed of 24.34 knots, whereas the actual speed was 22.80 knots, an error of nearly 7% for the patent log. In a paper read before the Marine Engineering division of the International Engineering Congress last summer, Mr. Wm. Cowles, M. Am. Soc. M. E., called attention to the need of improvements in ship logs, and suggested that a speed-recording apparatus could be devised by placing a small screw at the side of the ship and far enough from it to be unaffected by its motion. Electric wire connections from this screw to a revolution counter on the vessel would enable an accurate record of the ship's progress to be made, wholly unaffected by currents and tides. Such a speed indicator could be "standardized" by moving it through the water at a known velocity and observing its rate of error. Were a really accurate and reliable speed indicator available, contract speed trials would doubtless be made by their aid, and the instruments would be in large demand for general use on merchant steamers in place of the present inaccurate logs.

The brief but very important paper by Mr. F. H. Kindl, Structural Engineer of the Carnegie Steel Co., in another column deserves an examination

by those interested in extending the use of fireproof construction, and lessening to some extent the present enormous annual loss by conflagrations, which exceeds in the United States $100,000,000 per annum. For a long time the high prices of steel beams, which were maintained by a combination among the manufacturers, was a serious check on the adoption of fireproof construction, but for nearly two years now the prices of structural iron and steel have tended steadily downward, and as shown by Mr. Kindl elsewhere, steel joists in place ready for fireproofing now cost only about twice as much as ordinary wooden joists, and form only 20% to 40% of the total cost per sq. ft. of the completed floor. The arches and flooring, on the other hand, form 55 to 73% of the total cost of the finished floor, and Mr. Kindl claims that a reduction in this cost would in the long run prove profitable to manufacturers of fireproofing, by greatly increasing the demand for their products.

It is worth while pointing out, moreover, that even at present prices the difference in the cost of fireproof construction and firetrap construction is less than is generally supposed. While isolated dwellings will doubtless long continue to be built of the cheapest materials, regardless of fire risk, it appears from Mr. Kindl's figures that when the difference in insurance rates is taken into account fireproof construction is really cheaper than the old and hazardous construction for a large proportion of the buildings used for mercantile or manufacturing purposes, and even for the better class of city dwellings. It will take a long time, doubtless, to educate the owners and builders of this class of property to appreciate this fact, but it behooves engineers and architects to see that their clients are properly enlightened in this matter.

THE GREATER NEW YORK.

The "Greater New York," as now advocated by the Municipal Consolidation Inquiry Commission, of which Messrs. Andrew H. Green and J. S. T. Stranahan are the leading spirits for New York and Brooklyn, respectively, would cover an area of about 125 sq. miles and would include a present population of 3,000,000, making it the second city in the world in this respect. While there is no intrinsic value in mere numbers, there is a permanent value in a consolidation of municipal interests and the tendency of the majority of the large cities of the United States is in this direction. With the area proposed Greater New York would even then have an average population of about 24,000 per sq. mile, as compared with a density of 45,000 for its present estimated population of 1,850,000 divided over its 41 sq. miles of area.

At the present time 14 cities of the United States exceed New York in area, though falling far below it in density of population as a consequence. Selecting from these only those approximating our population we have, first, Chicago, with 1,450,000 people spread over 185½ sq. miles of territory and approximating 7.900 per sq. mile; and Philadelphia, with 1,142,000 inhabitants on 129 sq. miles of area, has 9,000 inhabitants per unit of area. New Orleans has an area of 150 sq. miles, but its population averages only 1,666 per sq. mile. Four cities have a population exceeding 300,000 located on an area smaller than New York, and have a consequent density of population approaching nearer to the present New York. These cities are as follows: Baltimore, 31½ sq. miles, with 16,000 per unit of area; Boston, 37 sq. miles and 13,000 per unit; Cleveland, 27 sq. miles and 14,000, and Cincinnati, 24½ sq. miles and 13,000 per sq. mile. It is thus evident that Baltimore most nearly approaches New York in its density of population, though it barely reaches one-third the figure credited to the Metropolis per unit of area.

The conditions of the territory surrounding old New York have been radically changed within a comparatively short time. Within the memory of living men even populous and near by Brooklyn was a comparatively insignificant town and over the rest of the area, which it is now proposed to include in the Greater New York, there were simply scattered villages without common interest, either in each other or with New York. To-day, many of these isolated village centers have expanded into important towns under the combined influence of general growth, private enterprise and the phenomenal increase in the facilities for travel. But while still retaining a separate existence and divided from each other by purely artificial lines, the real interests of all this outlying territory practically centers in the old New York; to it nearly all growth and material prosperity is due; and without it the area affected would still be in great part farm land with straggling village centers. While separate corporate existence was once necessary, it would now seem that all the ends of proper municipal government would be much more advantageously served by consolidation under one well-organized form of government.

The experience gained by the late creation of the Greater London should be valuable to us, for the previous conditions were much the same, though aggravated by a longer growth and a greater density of population at the time of change. Previous to the enactment of the Local Government Act of 1888, what is now the Metropolis of London, was controlled by the old City of London, and the various parish and county authorities, with all the conflict of interests due to independent control, and inseparable from it. The consolidation of all this territory, covering 688.3 sq. miles, into one community, and the creation of the London County Council to govern it has resulted in radical improvement in the conduct of public affairs and a much decreased general cost of administration. The Greater London is now an administrative county, with boundaries coterminous with those of the area fixed by the Metropolis Management Act of 1855. The county council is made up of 118 councillors, elected for three years by the rate-payers, and 19 aldermen, elected for six years by the councillors themselves. It has absorbed all the powers of the former Metropolitan Board of Works, the powers of the old county authorities and new powers conferred by the act creating it.

Compared as to density of population New York now has over five times more people to the sq. mile than the Greater London, and nearly three times more than any other American city. With the increased limits of the Greater New York, as now laid down, it would still have an average density of 24,000 per sq. mile, as compared with 8,200 for London and 16,000 for Baltimore, the next most crowded American city, when area is compared with total population. The area advocated by Messrs. Green and Stranahan includes substantially all of Long Island, west of Hempstead; all of New York, south of a line drawn from the northern boundary of Yonkers to Long Island Sound, at New Rochelle, and all of Staten Island. The populous Jersey shore opposite New York is left out because it lies in another state; though its interests are practically common with the area mentioned and its growth is due to its proximity to New York.

At the present time 20 odd separate governments control this area with divided counsel, and block all systematic and comprehensive schemes for common improvement. The people, however, who work in New York and live in what are now outlying towns and cities, want rapid transit; they want bridges over the streams, or tunnels under them; they need many things, in fact, which they can only get when all this territory is under a single control and all these wants become the wants of a single community. Until this is done well-devised and broad plans for improvement are impossible and the cost of execution cannot be equitably distributed, or met at all. While this centralization of power over so large an area and over such vast financial interests would seemingly present great opportunities and consequent temptation to the professional politician, the resultant increase in the popular vote can be depended upon to offset this tendency in great part. The dangerous political element, the one most depended upon to debauch the ballot, comes from the crowded tenement districts of a great city, and the extension of boundaries and facilities of transport would check, rather than increase, this crowding. In the Greater New York the decent, law-abiding and conservative element would always be in the real majority; and while this element is usually long-suffering and slow to rise it would have the power to reform its government whenever public scandal or bad government aroused it sufficiently to exercise that power. That this power exists even now has recently been shown in the complete upsetting of the Brooklyn bosses by a popular vote.

The time to consolidate and form the Greater New York is now at hand and no time should be lost in completing the movement already commenced. Improvements are being pushed and facilities are being created that constantly add to the population of the outlying districts that would be affected. But each separate community is now working out its future after plans deemed best for purely local advance and with little or no regard for the plans or needs of present or prospective neighbors. In 50 years or less the increase in population and the merging into one of what are now separate communities will compel consolidation, and it would then be consummated on much less advantageous terms. Much of the work now being done would have to be undone, or at least unified, and the adjustment of long-established and conflicting interests and methods would mean the expenditure of very large sums of public money, that could be saved by an earlier general control. Experience teaches that it is always better and cheaper to commence a work of this character upon a comparatively clear field, and to carry it to an end upon well planned and clearly defined lines. This can only be done, in the case of the Greater New York, by commencing now.

THE DEMAND FOR MINING AND OTHER ENGINEERS.

An interesting and significant paper on the "Growth of American Mining Schools and Their Relation to the Mining Industry," which has been for some time on our table awaiting abstract and review, was read before the International Engineering Congress by Prof. Samuel B. Christy, of the University of California, and has since been published as part of the transactions of the American Institute of Mining Engineers. The paper appears to have been called out by the articles in relation to engineering schools which we published in 1892, and it attempts to account for all the apparent relative decline in the importance of mining schools on grounds of relative supply and demand solely, without leaving room for any other hypothesis. Without being able to accept any of his conclusions fully, it must be admitted that Professor Christy makes out a good prima-facie case for his opinions; yet when the grounds therefor are carefully analyzed they lose much of their apparent force.

Especially is this true of his opening argument, which is a good example of that commonest of all errors in handling statistics, viz., picking out and contrasting single years at the beginning and end of a certain period under a tacit assumption that these years are typical. By doing this with a deceptive purpose almost anything can be proved by figures which will be swallowed by the credulous, as politicians well know. When done with strictly fair and honest purpose, as we are sure it was in this case, the usual result is that the author deceives himself.

In this particular instance this error of method lends plausibility to a premise which nevertheless is wholly false, viz., that the growth of mining schools, although slow, has been a real one, approximately comparable with the growth of the mining interest itself. To prove this, Professor Christy extracts from the table which we published Aug. 11, 1892, giving the number of graduates each year for every American engineering school from its foundation, the figures for 1880 and 1892 only, and contrasting these, shows that the total number of mining graduates has increased from 37 to 48, or " 1.3 times," while the total value of the mineral product has only increased "1.81 times" in the same period. Professor Christy thinks it "remarkable" that these ratios should agree so closely, and naively adds: "In fact, no one would have ventured to predict such a close agreement beforehand."

They would not, indeed, had they been prudent, for the very good reason that a moment's careful study of the full table will show that the two years 1880 and 1892 are not fairly indicative. Contrasting the five years 1888-92 with the five years 1878-82, the mean number of annual graduates from all our mining schools was 36.4 in the later period, to 39.8 in the earlier one, an actual decrease of nearly 10%, while the mining output was

increasing 81%. Were we to average the same five years for the mining output, moreover (which we cannot do for lack of the figures), we apprehend they would show that the mining output had actually increased more than 81%.

A glance at the diagram published by us Aug. 11, 1892, will show that these averages correctly represent the general tendency since 1877. On the other hand, if we look behind the figures a little, we shall conclude that there can hardly be said to have been any decided tendency to decrease in number of mining graduates. Rather, there has been an absence of any tendency to increase, and it may reasonably be contended that even this is due to the accidental fact that the mining schools got started before the mechanical, and so attracted students who would by preference have gone to mechanical schools had there then been any choice. To a large extent this is undoubtedly true of the civil engineering schools also.

When we come to the broader issue of the relative demand for civil, mechanical and mining graduates Professor Christy makes out a much better prima facie case, and yet one which is open to no little criticism. After making some warrantable corrections and allowances in the census statistics he continues:

This distributes the wage-earning population as follows:

Agriculture	44.10%
Professional and personal	23.43%
Trade and transport	10.41%
Manufactures and mechanics	20.30%
Mining and metallurgy	1.76%
	100.00%

Now, although some employment is given to engineers by the first two classes of wage-earners, most of it comes from the three latter classes, each of which is closely related to some one particular class of engineering work. Thus, the work of the mining engineer comes from the activity of those engaged in mining and metallurgy; that of the civil engineer chiefly from those engaged in trade and transport; that of the mechanical engineer from those engaged in manufactures and mechanics. The personnel of these industries, we have seen, were related numerically in the ratio of 1.76, 10.41, 20.30, or as 1 : 5.92 : 11.53. Hence it would seem in a general way as if the relative field for mining, civil and mechanical engineers in 1880 was roughly in proportion to the numbers 1, 6 and 12.*

Now we have found the number of graduates from the schools of mining, civil and mechanical engineering in 1880 were in proportion or 1 : 4.26: 1.11; and both civil and mechanical graduates, but especially the latter, were at that time much below their normal ratio.

If we examine the ratios of graduates in 1892 from the schools of mining, civil and mechanical engineering, we find them greatly altered; they have become 1 : 7.73 : 9.27. In short, then, unless the relative proportions of the wage-earning classes have essentially altered in the last ten years since this (1880) census was taken, the supply of civil engineers has most nearly approached the limit of demand, and that of mechanical engineers is still somewhat below it.

It will not do to push such reasoning too far, but it must now appear evident that the apparently abnormal growth of the schools of engineering has been in reality only a readjustment to make good an abnormal deficiency in the supply of mechanical engineers.

This is a strong argument with which we have no word of fault to find. The author continues it by an attempt to get at the absolute size of the field for mining engineers. To do this, he deduces from the report on "Mining Industries" of 1889 the following estimate of the total personnel of the mining industries:

Administration (office, 7,683; foremen, 17,828)..	25,511
Mechanics	45,217
Miners	242,207
Laborers	202,037
Boys	30,927
Pig iron operatives (not steel)	53,000
Total engaged in mineral industries (1889)..	598,989

From these figures Professor Christy concludes, making the further assumption that more than half of the administrative officials are bosses or clerks having no direct connection with the actual work of mining or smelting, that there are only 12,000 of these latter; and "to those familiar with mining work it must be evident that not more than half of these (or 6,000) would find the technical instruction of an engineering school necessary to the proper performance of their duties"; which is certainly a liberal estimate, as it amounts to a little over 1% of all those engaged in mining. The proportion of necessary experts to the total number employed is for obvious reasons less in mining than in transportation or manufacturing; but even if we waive this difference and accept Professor Christy's ratios above of 1 to 18, we reach the conclusion that, in the same sense that there is room in this country for 6,000 mining engineers, there is room for $6{,}000 \times 18 = 108{,}000$ (!!) civil and mechanical engineers—"which it isn't so," more's the pity! We wish it were! Professor Christy himself realizes and states that this is a very liberal estimate of the number of positions open to mining engineers, and evidently intended it to be so, in order not to overstate the degree in which the mining schools were meeting the "visible demand"; but when we look into some further facts it becomes doubtful if he has not done so after all, as follows:

Having deduced this total of 6,000, Professor Christy assumes an average working life of 30 years for the men in it, from which, he says, "it must be plain that to keep up the supply of 6,000 engineers there will be required 200 new men each year. The supply of graduates turned out by the mining schools in 1892, namely 48, is therefore not so extremely out of proportion to the demand as at first sight appeared."

The flaw in this argument is that its method is applicable only to an old established and stationary industry. But mining is not such an industry; it is and has been a very rapidly expanding one. For instance, as mining interests increased in the ratio of 1 to 1.81 between 1880 and 1891, and as 6,000 mining engineers are, by assumption, sufficient for the demand in 1889-91, only $6{,}000 \div 1.81 = 3{,}315$ were needed in 1880; whence we have for the normal yearly demand since 1880:

To keep good the old stock. 1-30 of 3,315	110
To supply expanding demand, 1-11 of (6,000—3,315)	244
Total new vacancies yearly	354
As against computed demand for merely keeping this industry going without increase, of	200

But even this understates the case. This computation relates in each case only to the number of men necessary to keep things going, after the mines are once established. In addition to this, a period of rapid expansion gives potential employment to great numbers of mining engineers in merely discovering, testing, establishing and constructing new mines and works, in excess of those which are always required merely to keep the industry as a whole in a stationary condition. Even after this correction is made, however, the total number of vacancies for mining graduates has been so literally estimated that the small number of graduates is not necessarily much disproportioned to the demand, especially as there is a further cause of great importance tending to reduce the field for them.

The general scheme of all the mining courses is to curtail the instruction given in civil and mechanical engineering by enough to much enlarge the instruction given in chemistry and metallurgy, to the end that the graduate may be fitted to do either the metallurgical or the engineering work of mining as occasion arises. Now at great numbers of large mines and works one man cannot do all of both these kinds of work, and in all such cases there will be a tendency to split this compound profession into two; to employ one or more men who are chemists and metallurgists and nothing else, and one or more who are engineers and nothing else. In this latter case it is obvious that the man who has attempted to cover both professions has no special advantage over the one who has restricted himself to either one alone. Except for the fact that the two professions cannot be entirely separated he would be at some disadvantage, because of his necessarily less complete knowledge of either single branch.

This leads directly to the issue "Are Mining Schools Justifiable?" with a discussion of which Professor Christy concludes his paper. With his main conclusion we entirely sympathize. This is in brief that the number of would-be mining schools of the first class is already too large; that it should be reduced from 20 or more to half a dozen; but that there is ample room for all the rest, and more too, in educating less thoroughly but effectively mining foremen and superintendents. As a part of his argument on this issue Professor Christy gives the following interesting table of the mining schools of the world:

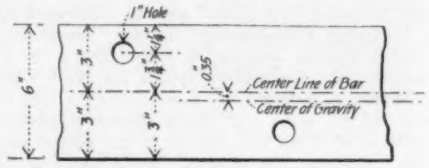
Attendance at Mining Schools for 1887.

American.		European.		
Columbia	87	*England*—Royal School of Mines	60	
Lehigh	68	*Saxony*—Freiberg	163	
Massachusetts Inst. Tech.	30	*Prussia*—Aachen	43	
		Berlin	104	243
		Claustal	96	
California	23	*Austria*—Leoben	29	
Pennsylvania	17	Klagenfurt	8	
		Mahrish	—	
Ohio	14	Ostrau	23	117
		Dux	17	
Lafayette	12	Pribram	40	
Michigan	8	*Sweden*—Stockholm	17	
Washington	7	*France*—Ecole des Mines de Paris	111	
Illinois	3	Ecole des Mines, St. Etienne	80	191
Wisconsin	3	*Belgium*—Liège	—	
Total	272	Total	791	

LETTERS TO THE EDITOR.

ECCENTRIC LOADING OF COLUMNS.

Sir: The letter from Mr. John C. Trautwine, Jr., in Engineering News of Nov. 23, on the subject of eccentric loading, has an application to riveted work which I think is not usually sufficiently considered. In figuring angles and plates, used as tension members in latticed trusses, etc., one or more rivet holes are deducted to obtain the net section. Suppose, for example, a 3 × 3-in. angle, the rivets being staggered, is flattened out into a 6-in. bar, we then have a section as in the accompanying figure:



Let the total load P = 5.

Net width of section w = 5, and mean unit stress =

$$p = \frac{P}{w} = 1.$$

Eccentricity of stress = 0".35. Bending moment =

$$Pd = 1.75 = f \frac{I}{y_1} = f \frac{14.25}{3.35} = 4.28\ f.$$

$$\therefore f = \frac{1.75}{4.28} = 0.41.$$

The maximum stress will be 1.41 p.

If two holes symmetrically placed are deducted from the section we have a mean unit strain

$$= \frac{5}{4} p.$$

In other words, the angle is stronger with two holes out than with one. Similar results will be found for larger angles. It would, therefore, seem that in estimating net sections of angles in tension, not less than two holes should be deducted and the rivets preferably placed opposite where practicable. Each leg should be connected so as to receive its share of the strain. A few tests on full-sized tension members of this character, especially short ones, could not fail to be of use. Yours truly, John C. Moses,

Jun. Am. Soc. C. E.

Cambridge, Mass., Dec. 9, 1893.

Sir: Referring to an article in your issue of Nov. 9, regarding eccentric loading of columns, Mr. Emperger will find in "The Engineer" of a year or two ago an account of experiments on steel struts, eccentrically loaded, together with a table of results. Although the pieces used were small, the figures obtained afford a rough test of the formula generally employed and quoted by Mr. Emperger in his article. On reducing to a basis of comparison the deflections given it will be found that this formula provides an excess of strength of 20 to 50%, so that if similar results hold for full-size columns the danger of eccentric loading is not as great as might appear.

* Employment for civil engineers comes partly from the occasional necessities of agriculture, and partly from the constant needs of municipal work. These would increase the estimate made above for the field of civil engineers. But, on the other hand, trade alone, as apart from transport, gives very little direct employment to civil engineers, so that on the whole I believe the above estimate is very near the truth.

* This estimate for students in the Royal School of Mines proper, for 1887, is made by an associate of this school. There were several other schools in England giving some instruction in mining, but this seems to have been at this time the only one with a complete course for mining engineers.

The real trouble, however, lies quite out of the designer's province. The shop foreman is convinced that anything is good enough for a building, and will allow his milling machine to run out an eighth of an inch to the foot without suffering from qualms of conscience. Then the inspector, if there is any, seems always to overlook testing the column ends for square facing. Finally, there is the fitter on the building who takes a modest pride in plumbing up the column "with a couple of bits of hoop iron under the corners instead of using half a dozen, like some men as "don't know no better."

All these besetting snares render square loading practically unattainable. The writer is acquainted with one instance where a steel column, designed for a square load of 1,500,000 lbs., rests entirely on one edge through defective milling, and the result is that according to our formula the extreme fiber stress is more than 35,000 lbs. per sq. in.

Yours truly, D. A. Watt.

New York, N. Y., Dec. 4, 1893.

Sir: In regard to the eccentric loading of cast iron columns I should like to call attention to the accompanying cuts from Professor Tetmajer's "Baumechanik," illustrating two forms of construction, which, although simple and practical in many cases, are not often used. Both tend to prevent the eccentric loading of columns. Fig. 1 shows how to produce concentric loads on the columns when the floor beams are unequally loaded by placing small plates, p, under alternate floor beams A A—F F resting on the longitudinal girders M N. In Fig. 2 the two unequal loads N and Y are made to produce a concentric load Z on the column by means of properly placed girder seats a and b on the columns.

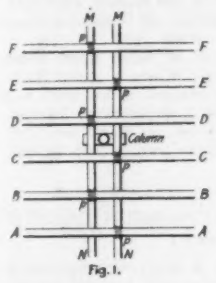


Fig. 1.

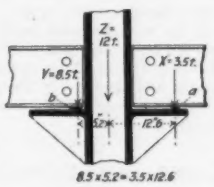


Fig. 2.

Yours truly, C. Z.

Jersey City, N. J., Dec. 6, 1893.

AN OLD PROBLEM RESTATED.

Sir: Will you, through the medium of your paper, kindly answer the following questions: What will be the effect under the following conditions: 1. A man seated in the stern of a sailboat working a pair of bellows directly against the sail.

2. A man seated on the gunwale of a boat working a pair of bellows against the sail in such a manner that the wind from his bellows strikes the sail obliquely. Yours very sincerely, D. R.

Anaconda, Mont., Nov. 17, 1893.

(1. If the sail be square, a slight backward reaction, equal to the loss by friction of the current of air through the still air. 2. If the sail be oblique, two forces at an angle to each other which, if their fore and aft components only be taken (that being the only direction in which the boat can move freely), leaves a larger excess of backward reaction. The old statement in books of elementary physics to the implied effect that a bellows worked in the stern of a boat can produce no effect whatever, though correct, of course, for all practical purposes, is not quite correct when strict exactness is sought.—Ed.)

SWITCH FORMULAS AS AFFECTED BY CURVATURE.

Sir: I feel that your criticism in Engineering News of Dec. 7 on the last chapter of Carhart's fieldbook is unjust. The lead is the least important of three things, the frog angle, the curve and the lead, treated in the pages on turnouts from curved tracks.

Now, if it is well to publish a chapter on frogs and switches at all (and you do not object to this), I fail to see why the simple cases on straight track should be given and the more complicated ones on curved tracks left out. For example, a No. 8 turnout from the outside of a 9° 24' curve makes a straight lead, while on the other hand the same frog used on the inside of the same curve makes a turnout with a curve of over 18°. Again, a No. 6 turnout from the inside of an 8° curve would make a curve that engines could not use, while if used on a straight track or from the outside of the same curve, the No. 6 turnout works all right. Should not these remarkable differences be taken notice of?

Is it not worth while, even at the expense of a page or so, to show how to find the angle and proper position of a frog used on a curved track where we are compelled to use a turnout of given radius? I have ordered one such frog since receiving the first copy of this book. Attention is called to the problems on crossing frogs and crossing slips as at least being new and not to be found in any other fieldbook.

We believe that the increased number of track connections required in recent years by extra main tracks, yards and terminal facilities has created a demand for such work as this. Very respectfully,

L. C. Weldin, C. E.

Pittsburgh, Dec. 16, 1893.

(Were our correspondent's premises sound, his conclusions would also be sound, but they are not. The three things which our correspondent says are the important ones about a turnout curve are:

1. Angle of frog, generally given by a number ratio, as we need not explain, which let = n. Then we have:

2. Lead, 9.5 n, "thar or tharabouts," and in any event always in sensibly constant ratio to n whether the turnout be from a curve or tangent.

3. Curve (expressed in form of the degree of curve) always $600 \div n^2$ (within a petty fraction) when the turnout is from a tangent, and always the same PLUS OR MINUS THE DEGREE OF MAIN CURVE when the turnout is on a main line curve.

This last fact does not seem to be known to our correspondent, yet his own example may illustrate it. Given a No. 8 frog, we have with—

Main line tangent; turnout curve, 9° 24'.
Main line on 9° 24 curve; turnout tangent if it be outward.
Main line on 9° 24' curve; turnout 18° 48' if it be inward.

Moreover, what does the degree of the turnout curve matter, anyway? Is our correspondent in the habit of setting up his transit to run in the turnout curve, given the number and position of the frog and the length of lead? Surely not; and there is another too little known fact about turnouts which makes even a knowledge of the turnout radius unnecessary. At the middle point of the lead the offset from main rail to turnout rail is always one-quarter of gage, and at the quarter points it is 1-16 and 9-16 of gage, respectively, wholly regardless of the number of frog, length of lead or character of alinement. As for the middle ordinate for bending rails it is always $12 \div n^2$ more (or less) than the main curve ordinate for 30-ft. rails, and for other rail lengths, in proportion to the squares of the respective lengths. Or, if the degree of the turnout curve is known, it is 0.02 D for 30-ft. rails. The only additional fact needful to bear in mind in applying these rules is that the physical and the mathematical beginning of turnout curve are not necessarily nor usually at the same point.

By working on these lines a little further a complete set of simple and compact working rules which are broadly applicable to all conditions are easily devised.—Ed.)

THE ELASTIC THEORY FOR MASONRY ARCHES.

Sir: The correspondent, "R. A. C.," in your issue of Dec. 28, 1893, who asks for information on the application of elastic theory to the masonry arch, can find such information in the following publications: "Lanza's Applied Mechanics," pp. 841-2; an article by Professor Swain in "Van Nostrand's Engineering Magazine," October, 1880, and also if he reads French, in "Ponts en Maconnerie," par Degrand et Resal, pp. 109 et seq, and "Systemes Elastiques," par A. Castigliano, pp. 312-4 and 446 et seq.

Very respectfully, Charles W. Sherman.

Ithaca, N. Y., Jan. 5, 1894.

NUMBER OF LEVERS REQUIRED IN ENGLISH INTERLOCKING PRACTICE.

Sir: There is one paragraph particularly in your article on a complicated system of railway tracks in your issue of Nov. 16, 1893, to which, in justice to installations in this country, I think I must take exception. The subject is the "Interlocking by the Pneumatic System of Stewart Ave. and 21st St. Crossing, Chicago." It is stated that to have handled all these parts, that is to say, the switches, etc., together with all the accompanying locks, lock bars, etc., on an ordinary lever machine, using English practice of connecting parts, would have required one with 275 levers. Such a machine, you state, would require the constant attendance of not less than 12 men, which, by dividing the day into three parts, would mean 36 men, besides the repairmen and train directors.

In order that I might not make a statement which I could not substantiate, I have been to the "A" box at Waterloo (London & South Western Ry.) this morning and have ascertained the total number of men required for the working of this signal box. For a complete description of the installation I would refer your readers to the Engineering News of June 23, 1892.

There are at Waterloo in the signal box, operating the 236-lever frame, never more than four signalmen, and there are three shifts of such men to the 24 hours, making the total number of signalmen 12 in all. There is one signal fitter, one assistant fitter and one laborer employed in keeping not only the "A" box, but the Windsor Line box, the Crow's Nest box at Waterloo station and the "B" box some 300 yds. down the line, in repair.

The switches and slips which are comprised in the Stewart's Ave. scheme are, as I presume, those enumerated in your article, namely, 40 single switches, 22 double slip switches, with movable crossing points, and 86 signals, and you state that it would be necessary, if this was signaled in England, to have 275 levers.

I can only refer you to your own article in the Engineering News of the date stated, under which the switches, signals and facing point locks, operated by the locking frame there, comprise 102 signal levers which work 247 different signals, 50 point levers which work 81 switches, 46 facing point lock levers which work 68 facing point locks, 7 gear levers used only for operating the simplex gear, 16 setting levers used simply for setting different changes of interlocking and 15 spare levers, comprising the total of 236. I call your attention to the 86 signals operated in the Stewart Ave. scheme against the 247 signals operated at Waterloo.

I have expressed my opinion before in the matter of the pneumatic versus the manual system, and I need not again express it here. I think that there is very little doubt, from a personal examination of any large installation in this country and any correspondingly large installation of pneumatic plant in the United States as to which is the cheapest in maintenance.

Faithfully yours,

John P. O'Donnell, M. Am. Soc. C. E.,
Consulting Engineer National Switch & Signal Co.

London, Dec. 27, 1893.

NOTES AND QUERIES.

F. A. K asks whether any experiments have ever been made to determine the strength of brick of different grades at temperatures considerably below the freezing point. It is well known that brick will absorb a large quantity of water, and it is questioned whether, when this water is frozen, an initial strain is not brought to bear on the particles of the brick which will greatly decrease its ultimate strength.

R. W. P. asks for particulars as to the corrosion of underground pipes by the return current of electric street railways. He will find such particulars in our issues of Sept. 22 and Dec. 29, 1892, and Sept. 14 and Sept. 28, 1893. In brief, the facts are that considerable corrosion of underground pipes has been caused by the return current of electric railways. The best practice in constructing such railways at present, however, is to furnish a metallic path for the return current, either through the track rails or through independent return wires. With such a metallic return, properly constructed, any ground currents which might occur through leakage would be so very weak as to be incapable, so far as can be seen, of doing any material harm.

THE CARNEGIE OFFICE BUILDING, PITTSBURG, PA.

We show herewith a view, reproduced from a photograph, of the steel framework for the Carnegie office building at Pittsburg. The illustration will doubtless excite general interest among those of our readers interested in steel construction by reason of the cross bracing seen between the columns. We will explain at the outset, however, that this bracing is only temporary and is designed merely to prevent injury to the steel framework from wind pressures while it is in process of construction and exposes only an open skeleton surface to the wind. As the walls are carried up and the surface exposed to the wind becomes the whole side of the building, this bracing is removed and the walls alone are relied on to take up the wind strain.

The matter of provisions for wind strains in the steel framework of high buildings has been so much discussed pro and con of late, that we shall say nothing further with reference to it in this

article, merely calling attention to the practice followed in this structure.

The steel frame was manufactured from the raw ore to its finished condition entirely by the Carnegie Steel Co. The ground space covered by the building is 120 × 100 ft. It stands 238 ft. high above the foundations. The basement was completed July 7, 1893, and the steel frame was completed Sept. 7. The entire work has been in charge of Mr. F. H. Kindl, Structural Engineer of the Carnegie Steel Co. We are indebted to him for the following further description of the building:

The building is of U form, with an interior court 30 × 60 ft. The structural material consists of rolled steel shapes, the basement columns resting on foundations built of steel beams, which rest directly upon the shale bottom usually found at this level in Pittsburg, about 6 ins. of concrete being used underneath the lower course to level up the beams and give them a uniform bearing. Between these beams is rammed concrete. There are three layers of these beams, each being figured to sustain the respective load coming upon them. The columns are of the standard Carnegie steel Z-bar or Strobel type, now generally adopted in most structures of this character, owing to their cheapness of workmanship and the substantial manner in which they can be bonded in the brickwork, which surrounds them completely and acts as a fireproofing medium.

The floorbeams used are mostly 12-in., weighing 32 and 40 lbs. per ft., while the girders consist of 15-in., 20-in. and 24-in. beams. All the steelwork is riveted throughout, in shop as well as in erection. The columns are made continuous by the use of splice plates about 3 ft. long, giving great stiffness to the framework. The erection was greatly facilitated by the fact that all the columns were made in two-story lengths. Thus the erection rigging had to be moved only at the completion of every other story, instead of at each story, as is usually the case.

The outside walls will consist of Portage Entry sandstone, carried up to the second-floor level, above which they will consist of red pressed brick and terra cotta finish. The court will be faced with white glazed brick from top to bottom. The fireproofing between the beams will consist of 12-in. terra cotta arches laid with their webs perpendicular to the webs of the beams, and it is what is known as "end construction." Upon these arches will be placed 3 ins. of concrete, in which are embedded wooden sleepers, and to these will be nailed the finished floor. The plaster is applied directly to the arches from below.

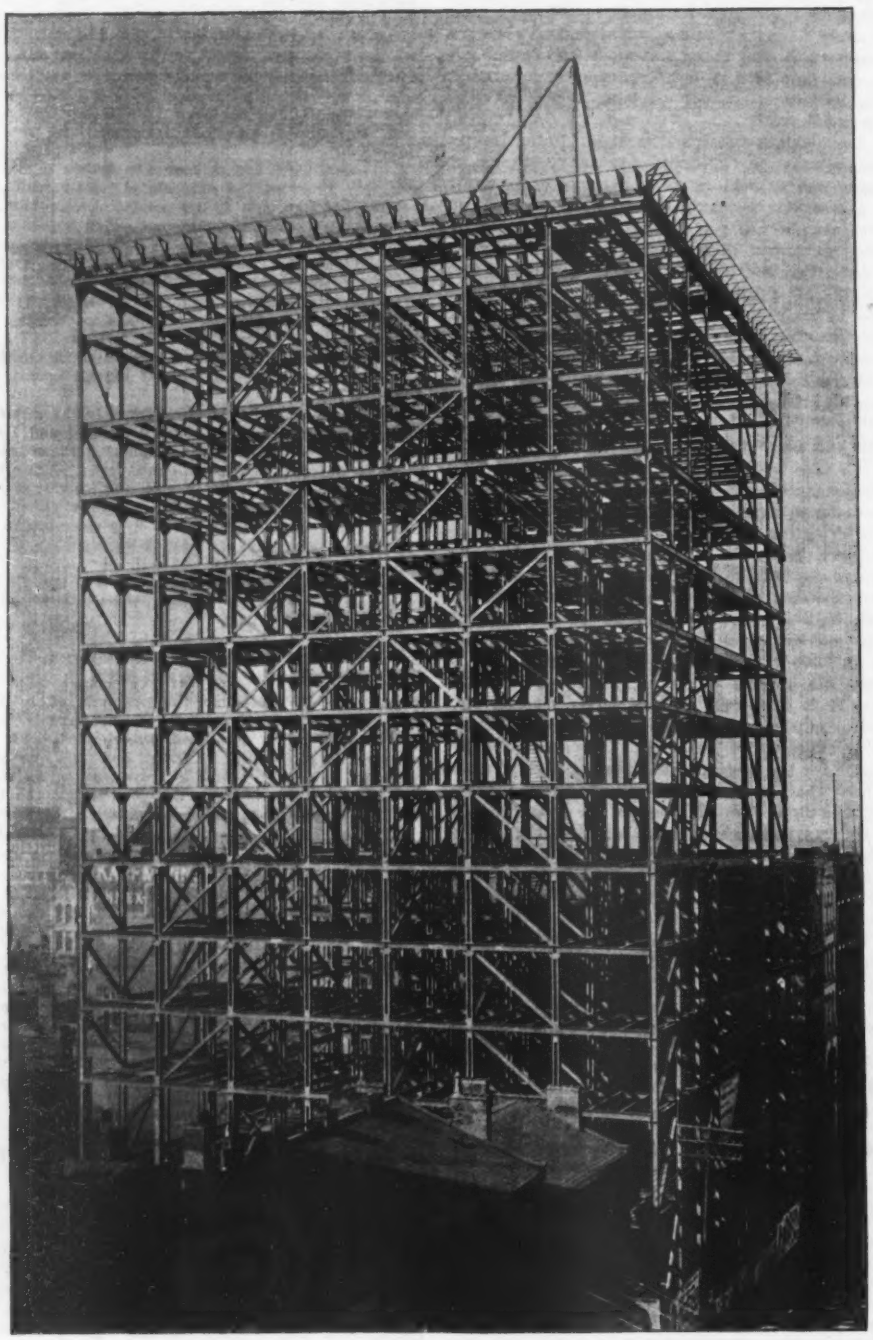
The power plant will contain one 250 and 125-HP. water tube boilers, all fitted with automatic stokers. These will obtain their coal supply from a pair of hoppers opening up to the sidewalk, thus reducing the cost of firing to a minimum. There will be three compound engines directly coupled to dynamos, each supplying 1,000 incandescent 16-c. p. lamps.

There will be six hydraulic elevators having vertical cylinders, one of which is arranged for freight. There is also to be a hydraulic elevator in the rear, upon which any freight is taken to the cellar and then transferred to the other elevator, thus avoiding passage through the main hall of the building.

The whole building will have a most complete system of heating and ventilation, there being a constant supply of fresh air sent to each room while the foul air is drawn out by two large fans placed on the roof and driven by an electric motor. The temperature of each room will be automatically regulated by means of thermostats which act directly on the steam inlet valves of the radiators, thus keeping an even temperature in the rooms.

On each floor there will be spigots for drinking water, which will be sterilized, filtered, and cooled by an ice machine to a temperature of about 40°, thus doing away with the use of ice water, and the water being sterilized will contain no germs.

The different departments of th company will have pneumatic tubes all leading to one central exchange, thus furnishing a ready means of communication. All the floors above the sixth will be let to other tenants, and upon each of these floors there will be a connection with the Western Union Telegraph Co., which will have a station in the main hall of the building. The building is expected to be completed and ready for occupation in about one year from date, most of the contracts having been already sublet.



VIEW SHOWING IRONWORK FOR THE CARNEGIE OFFICE BUILDING, PITTSBURG, PA.

A NEW QUADRUPLE-EXPANSION ENGINE.
(With inset.)

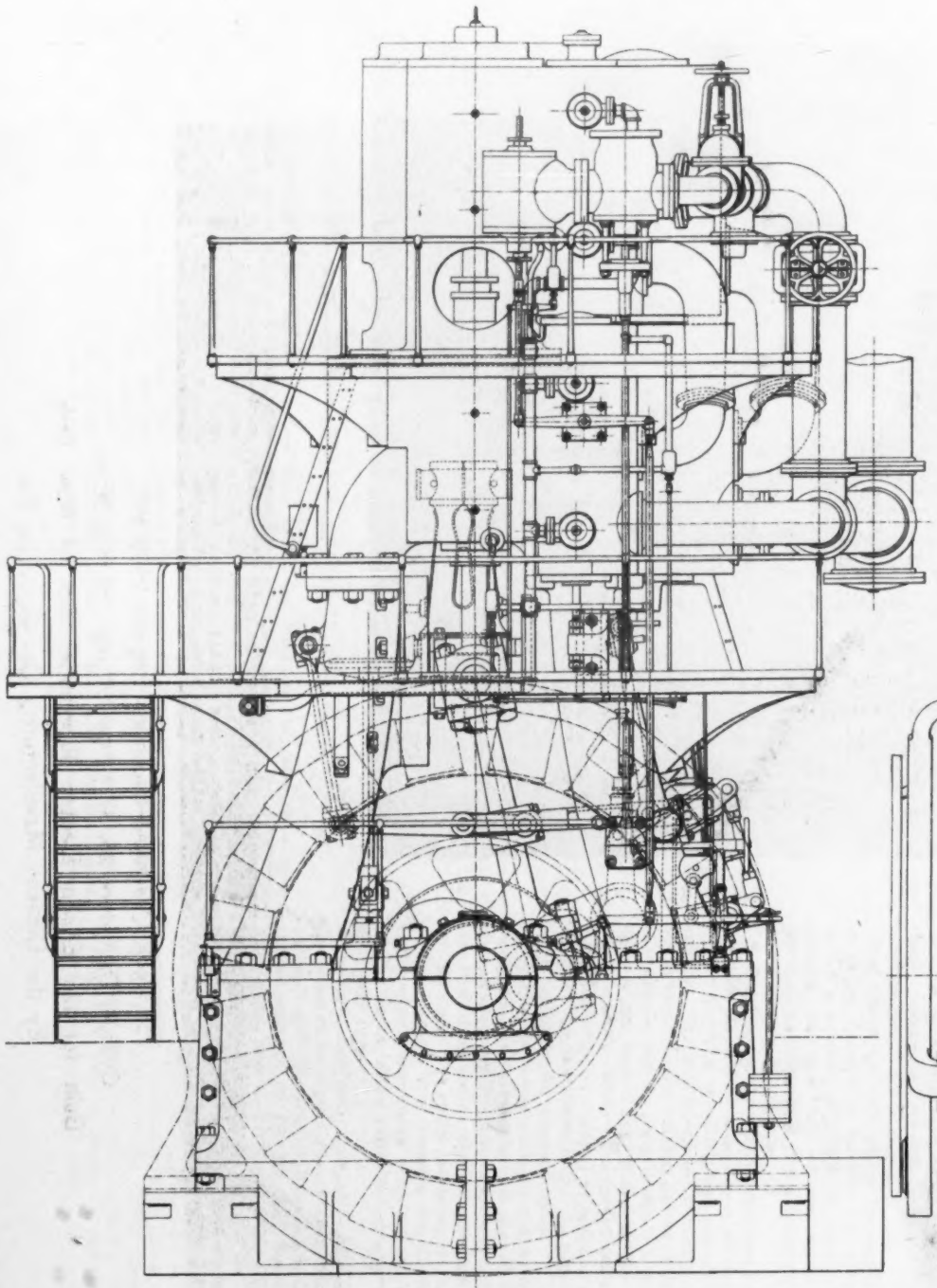
We illustrate this week a quadruple-expansion engine of 2,500 HP., recently built for the Edison Electric Illuminating Co. of New York City, by the Dickson Mfg. Co., of Scranton, Pa. As seen by the drawings, the engine is of the marine, vertical inverted type, a style of engine which has within a year or two come into considerable popularity for electric station service, chiefly on account of the facility with which a large amount of power can be obtained from a small amount of floor space. The dynamos driven by this engine are multipolar generators with stationary fields, and armatures mounted directly on the main shaft of the engine and forming its only flywheel. In this case, as in the case of all the multi-expansion engines previously constructed for this company, no "outboard bearings" are employed.

Our perspective view shows the engine as set up in the shops of its builders; but when put in service a generator of 800-K-W. capacity will be mounted on each end of the shaft. These generators are being built at the Schenectady shops of the General Electric Co.

In the design of the engine it has been attempted to secure the greatest compactness without in any respect sacrificing the safety and reliability of the machine. The Elm St. station is located only two blocks from the office building district of New York city, and the land on which it stands is equaled in value by the sites of few, if any, electric stations in the country. Under these circumstances it becomes important as a matter of economy to select a type of engine which will give the largest power while occupying the minimum space.

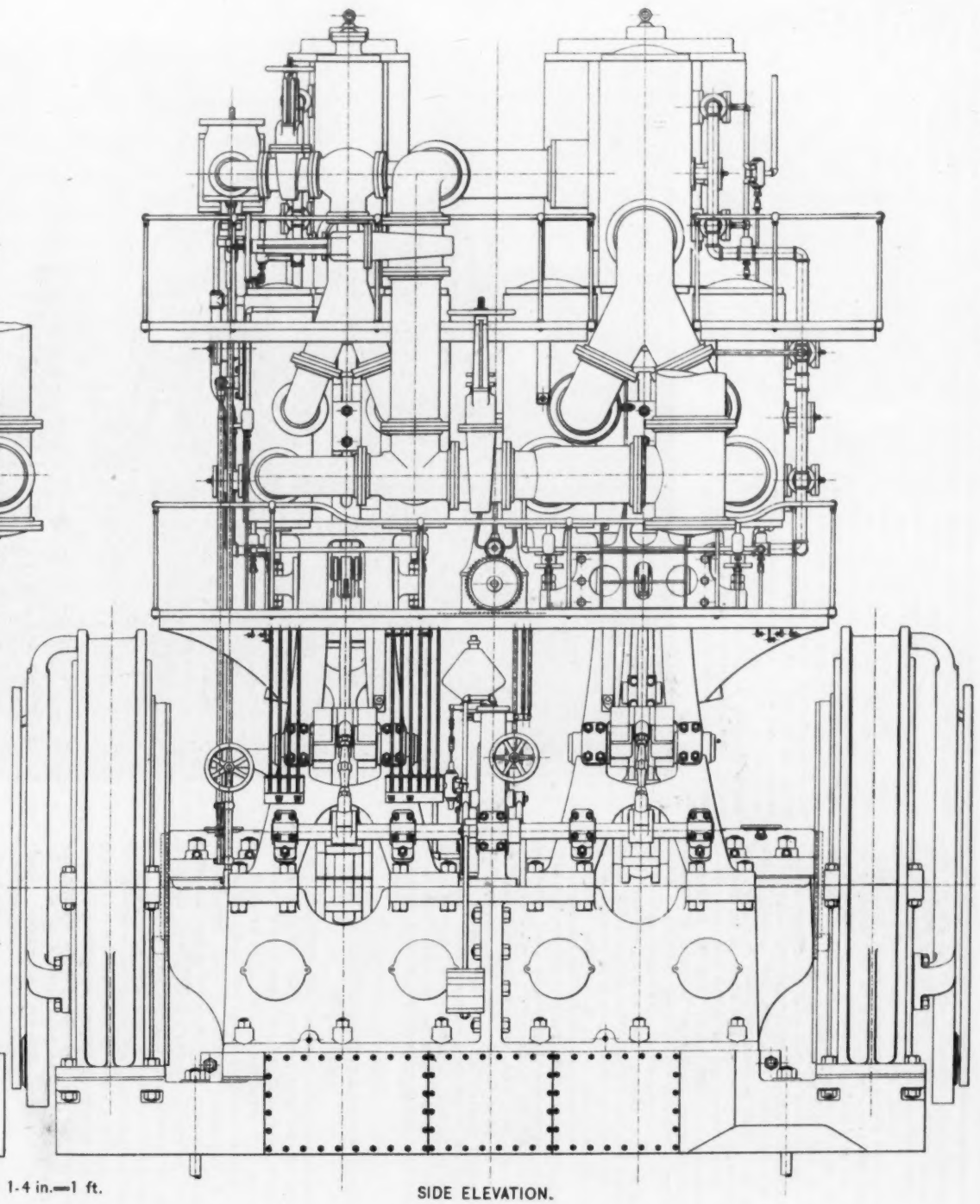
Referring to the drawings, it will be seen that the engine has two cranks, one worked from the high-pressure and first intermediate cylinders; and the other by the second intermediate and low-pressure cylinders. The steam chests are on the fronts of the cylinders, thus lessening the length of the engine while increasing its width and stability, and making access to the valves for adjustment or repairs very easy.

The small floor space occupied by this engine in proportion to its power may be appreciated by comparing it with the great Allis quadruple-expansion engine exhibited at Chicago last summer. The Allis engine was a horizontal Corliss with cylinder diameters of 26, 40, 60 and 70 ins. Its stroke was 70 ins., and its speed 60 revs. per minute, or 700 ft.; while on the other hand, this engine has cylinders 26, 37, 52 and 72 ins. in diameter and 3-ft. stroke, making a piston speed of 540 ft. per minute, at its regular speed of 90 revolutions. Thus the two engines are seen to be not far from equal in power. In space occupied, however, the contrast is great. The Allis engine



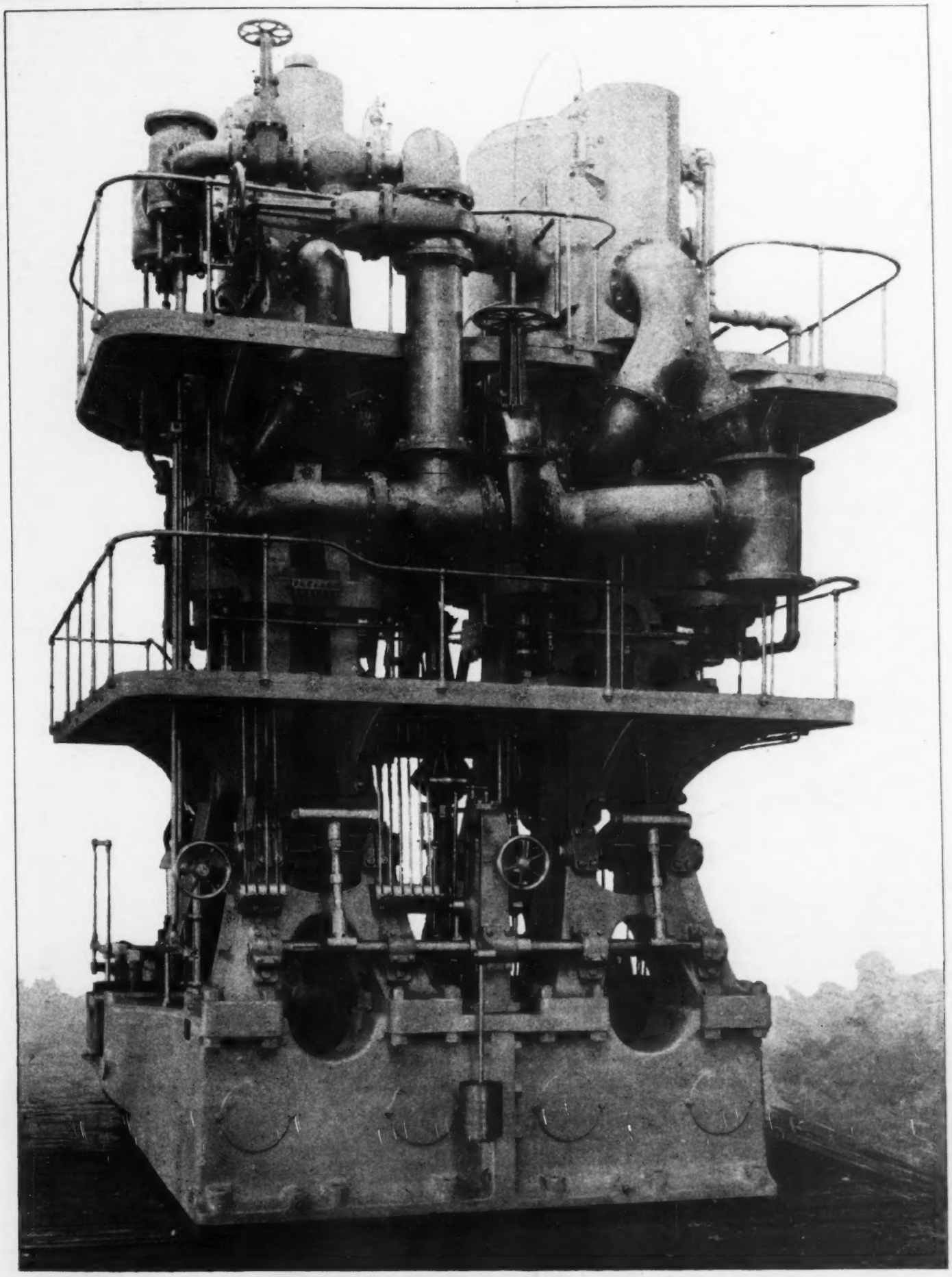
END ELEVATION.

Scale 1-4 in.=1 ft.



SIDE ELEVATION.

Van Vleck Quadruple-Expansion Engine; 2500 HP. Cylinder Diameters, 26, 37, 52 and 72 ins. Stroke, 36 ins.
Built for the Edison Electric Illuminating Co., of New York. By the Dickson Manufacturing Co., Scranton, Pa.



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CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

occupied a floor space about 37 × 50 ft., or about 1.46 HP. per sq. ft.; the Van Vleck engine is 13 ft. 8 ins. wide, and 17 ft. 9 ins. long over bearings, and thus generates nearly 10 HP. per sq. ft. of floor space. Of course, the Van Vleck engine stands much higher than the Corliss, measuring 25 ft. over all.

The main shaft of the Van Vleck engine is a soft steel forging bored hollow, and is 18 ins. in diameter in the end journals and 16 ins. in the center journals. The end bearings are each 36 ins. in length. The pistons and cylinder covers are steel castings, the pistons being of a coned form, following customary marine practice.

The piping between the cylinders is so arranged and provided with suitable valves that either pair of cylinders can be cut out and the engine run as a compound. This can be done with no great complications, as there are no receivers or reheaters between the cylinders.

Steam is distributed to all the cylinders by piston valves, which are worked by the Joy valve gear. The governor is of a modified Porter-Allen type, altering the point of cut-off on all four cylinders simultaneously through a hydraulic cylinder. Besides this, the turn-buckles on the valve rods permit the engineer to alter the cut-off on any cylinder while the engine is running. It is believed that this feature in the regulation—controlling the cut-off of all cylinders simultaneously—will make the engine respond much more quickly to its governor than is the case where a single cylinder alone is altered in cut-off by the governor.

The engine is designed to work with steam at 200 lbs. to 225 lbs. initial pressure and will run noncondensing. The exhaust steam is utilized as far as possible to work exhaust injectors for feeding the boilers and for heating the feedwater. With the very high steam pressure used, the loss by not using a condenser is not serious.

The new Elm St. station, now near completion, is designed to accommodate on its ground floor no less than ten engines of the size and style illustrated on our inset sheet. Five 600-HP. and two 1,250 triple-expansion engines of the same general type are now doing service in the various stations of the New York Edison Co. The 2,500-HP. engine which we illustrate has just been set to work, and if satisfactory, duplicates of it are to follow as fast as the demand for power makes it necessary.

AN AFRICAN SAWMILL.

A correspondent sends us a copy of "Die Fliegende Blaetter" containing the cut here reproduced and suggests that—when the means are available and controllable—there is a valuable hint therein to engineers who would saw off piles under water. As a suggestion it is piquant enough; but we would not recommend its too hasty adoption by members of the profession. Thomas Telford defines the profession of civil engineering as "the art of directing the great sources of power in nature for the

An African Sawmill.

use and convenience of man." Under this definition, we suppose, the complacent African, perched on the improvished sawbuck, must be classed not only as a man and a brother, but also, in the strictest sense, as an engineer; since he is doing exactly what the definition calls for—and nothing else. Few engineers of more civilized countries conform so closely to the terms of this often-quoted definition.

WRECK OF BRIDGE OVER THE YELLOWSTONE RIVER, SRPINGDALE, MONT.

We illustrate in the accompanying cut the wreck of a 220-ft. span highway bridge crossing the Yellowstone River between Springdale and Hunter's Hot Springs, in Montana, which, curiously enough, was destroyed on the night of Dec. 15, 1893, signalized by the fall of the great 546½-ft. span of the Louisville & Jeffersonville Bridge, as fully described in our issue of Dec. 28, 1893. The two accidents are of course in no sense comparable in magnitude or the disastrous consequences, but yet they teach much the same lesson. Both wrecks seem to have been due to the defective condition of the wind bracing, which brought the strains due to the wind pressure upon members and connections not designed to take them, with the result that the bridge failed.

The conditions of the failure of the Springdale bridge are given as follows in a letter from Mr. Charles Tappan, civil engineer, Livingston, Mont.:

Sir: During a very heavy windstorm on the night of Dec. 15, 1893, the bridge across the Yellowstone River between Springdale and Hunter's Hot Springs was thrown into the river. No one was present at the time. This bridge was a combination Pratt truss of one span, erected last May, by the Gillette & Herzog Mfg. Co., of Minneapolis, Minn., and it was the longest

WRECK OF COMBINATION HIGHWAY BRIDGE OVER THE YELLOWSTONE RIVER, NEAR SPRINGDALE, MONT.

single span in Montana. Its dimensions, as shown by the contract with the county commissioners, were as follows: Length of span, 220 ft.; length of panel, 20 ft.; height of truss, 30 ft.; clear roadway, 16 ft.; static load, 800 lbs. per lin. ft.; moving load, 800 lbs. per lin. ft.

At the site the river runs about east, and the bridge was broadside to the heavy west wind. On the evening of the 15th, when the last crossing was made, the bridge was swaying to such an extent that the driver had difficulty in getting his horses across. I inclose a photograph of the wreck, taken from the upper edge of the south abutment. The flooring is floating on the river and the bend downstream near the north abutment shows the place of strongest current and deepest water. The bridge pulled away from the north abutment, and the feet of the south end struts remained nearly in place.

The only examination for acceptance after erection was made by the county commissioners themselves, none of whom were engineers or experienced in building matters. After the accident the superintendent of bridges for this division of the Northern Pacific R. R. was employed by the county commissioners to make an examination of the wreck. He reported as follows:

In compliance with your request I made an examination of the combination bridge across the Yellowstone River at Springdale, Dec. 22. As to whether the bridge fell or blew down I presume it was the latter. There could, I suppose, be different theories advanced, but my opinion is that the prime cause was a faulty lateral system, particularly the bottom one. I presume your plan of this bridge will show exactly how same is constructed. If you will examine closely you will find that, at each end panel where first set of lateral rods is placed, there is no lateral strut, nor is there any other arrangement, except the weight of the span, to act as a resistance to the tensile strain of said first set of lateral rods. It surprises me very much that a bridge company, trying to make a reputation, should overlook so important an item and one of such small expense. From all indications it would appear to any man conversant with the construction of truss bridges that the absence of the aforementioned strut in this case has been the prime cause of the accident. Of course there might be other causes, which it is impossible for me or any other man to find out now, but this in itself would be sufficient under a heavy wind strain to cause the result. I will further add for your information that I think it a great mistake to have independent sections of top chord in so long a span. In theory it is all right, but in practice it is not.

There was another element of weakness which was not without effect, and that was entire lack of attention and adjustment since erection. This dry climate causes the best seasoned wood to shrink and warp (even the best make of rules and triangles soon lose their shape), and in six months the pine members had so changed as to make the bridge dangerously loose. The wreck is now being fished out, and the bridge is to be again erected by the original builders at the expense of the county.

RECENT PROGRESS IN THE MANUFACTURE OF STEEL CASTINGS.

At the recent meeting of the American Society of Mechanical Engineers a paper on this subject* was read by Mr. Henry L. Gantt, formerly Superintendent of the Midvale Steel Co.'s foundry, and more recently General Superintendent of the American Steel Wheel Co. The paper described the progress made in steel founding during the past two or three years, prefaced by a brief record of the development of open-hearth steel casting in this country. The art of casting soft open-hearth steel should not be confounded with the much older art of casting crucible steel. Successful open-hearth steel casting in this country dates from about 1886 or 1887. The improvements introduced during the past few years have been chiefly in the use of hotter metal, and larger sink heads. Cold metal is apt to chill the nozzle of the ladle and cause a leak there, and thus a small amount of metal runs into the mold while the ladle is being gotten over the runner. This metal cools at once and makes a bad spot in the casting, or if the leak is a bad one it may block up the runner entirely and cause the loss of a mold, or it may so cover the flasks by the molten steel as to make it impossible to separate them afterward without heavy loss by breakage. Again, it has been customary to throw the silico-spiegel necessary to prevent blowholes into the ladle in lumps while the steel is being tapped from the furnace. If the metal is cool and slightly viscous, the added spiegel will not mix thoroughly with the steel, and there will be lack of homogeneity in the casting, and more or less "hard spots" and "loose places." In the

* A previous paper on the same subject by Mr. Gantt was published in our issue of June 20, 1891.

best foundries it is now the practice to melt the silico-spiegel before adding it to the steel.

Designers of castings are gradually learning that a steel casting must cool from the bottom up; and founders now fix at once on the heaviest part of the casting for the sinkhead, which is usually made about 20% of the total weight of the casting.

By strict observance of the rule that a steel casting should be, as far as possible, of uniform thickness throughout, castings as large as 20 ft. long and 10 ft. wide have been made during the past few years. A fact which is not generally understood is that it is at present much more difficult to get good steel castings of large size than of small size. The reason is that most steel founders use open-hearth furnaces, melting from 5 to 20 tons. To pour even five tons of steel into castings averaging 100 lbs. in weight would, as a rule, take so long that those poured last would be of poor quality on account of the cooling of the metal. This difficulty may be overcome by substituting a small Bessemer converter for the open-hearth furnace. With this two or three tons of metal can be obtained when wanted, as hot as desired. Another advantage is that a number of different kinds of steel can be made in a day with a converter, against two or three heats only with an open-hearth furnace. Thus the founder having a converter can fill orders calling for a variety of grades of metal more readily than one using an open-hearth furnace.

A recent important improvement in steel founding consists in making castings having certain faces much harder than the body of the metal. This is effected by lining the faces of the mold which will lie against the surface to be hardened with a metallic alloy in a powdered state. For stamp shoes, crusher jaws, hammer dies, etc., ferro-manganese is best; but if it is desired to do machine work on the face and make it extremely hard afterward, ferro-chrome is most suitable. The fact that a soft steel casting can be produced having a face that can be hardened without making brittle the remainder of the casting is one of much importance to the arts.

A MODERN DISINFECTING PLANT.

A paper was read at the recent meeting of the American Society of Mechanical Engineers by Mr. W. H. Francis, Secretary of the Kensington Engine Works, of Philadelphia, describing the plant of the disinfecting stations established by the Marine Hospital Service. Each station is provided with apparatus for disinfection by three methods, heat, fumigation and immersion in disinfecting solution. The heating is effected in large rectangular chambers, each about 16 ft. long, 5 ft. high and 5 ft. wide. They are constructed of an inner and an outer steel shell 2½ ins. apart with screw staybolts connecting the inner and outer shells. The end frames are of cast iron, and intermediate trussed bands strengthen the shells. The author continues as follows:

The doors have concave steel plates riveted to cast angle frames fitted with heavy rubber gaskets; they are handled by convenient cranes and drawn tight by drop-forged steel eye-bolts, swinging in and out of slots in the door frames. A number of chambers, notably at Charleston, Mobile and San Francisco, are plain, cylindrical and unjacketed, but this style is open to objection. The rectangular form was adopted in preference to round, as it gave the most effective space during exposure, with little loss of steam, and enabled cars on track to be readily handled in and out. The jacket was used to give perfect circulation and distribution of heat, to prevent too rapid condensation and to dry the goods exposed. The jackets, which are filled with steam during the entire operation of the plant, make the chambers drying ovens, so that the articles to be disinfected are brought to temperature before the admission of steam to the inner chamber and thoroughly dried after the steam has been exhausted.

In the experiments by Dr. Koch, in connection with Dr. Wolffhugel, it was found that hot air alone, even at temperatures of from 230° to 248° F., after an exposure of three hours, would not destroy the bacilli. It was necessary, therefore, to eliminate the possibility of air pocketing in the chambers, or even permitting a mixture of steam and air to remain during exposure. To prevent this, a vacuum pump was attached to the system of piping, whereby a vacuum of 15 to 20 ins. was produced in the chamber before the admission of steam.

In all previous chambers, so far as the writer is informed, this important point was neglected and accounts for the reported unreliability of a number of plants.

For convenience of handling the goods four cars have been provided, of light wrought iron construction, with removable trays covered with galvanized screens, having a series of bronze wardrobe hooks in the top, permitting the articles to be laid out upon the trays, or, in the case of finer clothing, to be hung upon the hooks. The doors at both ends allow the cars to be brought in at one end and removed at the other, thus securing complete isolation of the infected and disinfected articles. After exposure, these cars, upon being unloaded, are returned to the working end of the chambers by means of transfer tables and side tracks, enabling a continuous alternating working of the plant.

As to the exact temperature required, the "doctors disagree." The consensus is from 100° C. (212° F.) to 115° C. (239° F.). This plant has therefore been arranged for any pressures up to, say, 15 lbs. (250° F.) if required, the steam being generated in the boiler at high pressure and the reducing valve set to the pressure required.

The system of piping is so arranged that steam may be admitted to the bottom or top of the chambers at will, through several openings and have perfect circulation. Galvanized hoods are placed in the chambers, so that steam is not forced directly on the clothing. Each chamber is provided with thermometers to register the temperature, vacuum and steam gages, safety valves, traps, etc., and is covered with magnesia non-conducting covering.

Fumigation is generally by sulphur dioxide gas produced by burning sulphur in the air.

In this plant a double furnace has been provided with small fireboxes at each end, over which are two cast iron shallow basins, about 5 ft. long each, the whole inclosed in a sheet iron frame. The sulphur is placed upon the basins and the fire lighted, quickly melting the sulphur, which soon ignites. To prevent too rapid combustion, baffle plates are arranged, and the proper quantity of air admitted through adjustable valves in the furnace fronts. The fumes thus generated pass to a reservoir, from which they are sucked by an exhaust fan, and are thence forced through piping and large flexible asbestos hose to the apartment to be fumigated.

Disinfection by chemicals in solution is generally effected with corrosive sublimate, carbolic acid and chloride of lime. The first is most frequently used, the strength being about 1 to 1,000. A large wooden tank is provided with a steam pump piped thereto. The chemicals are placed in a heavy keg perforated with numerous small holes, arranged at the top of the tank, and the water in sufficient quantity pumped into it slowly, making the solution of required strength. This solution is then pumped through 1-in. hose under pressure, insuring penetration into cracks and corners of the apartment being disinfected.

COMPARATIVE COST OF WOODEN AND FIREPROOF FLOORS.

By F. H. Kindl, Structural Engineer, Carnegie Steel Co.

Having had numerous inquiries and much correspondence relative to the cost of wooden and fireproof floors, the writer has compiled the table of such costs, which is presented herewith, and which will be interesting to engineers, architects, contractors and others interested in the subject. In order that a close relation could be established between the two floors it is assumed that in both cases the wooden joists, as well as the steel beams, rest upon two walls, and no other factors, such as columns, girders and walls, have been considered.

From this table it is apparent that it is not, as is generally supposed, the cost of the steelwork which makes the price per square foot of a fireproof floor so much above that of a wooden floor, but it is the cost of the fireproofing material. Steel beams can now be had for less than 1.5 cts. per lb. f. o. b. at the mills, and, in fact, they can be had all fitted and erected in place, ready for the fireproofing, for about 2 cts. per lb.

With this reduced price it is the hope of all mills manufacturing structural shapes that the demand for structural material will be greatly increased. It will be seen from these tables, however, that the amount of this increase will depend very largely upon the cost of fireproofing, which has had thus far no such decline in prices as has occurred with structural steel. Considering the possibility of these prices for fireproofing being brought within the reach not only of those contemplating the erection of office buildings, but also to those contemplating the erection of dwellings, the increased demand for fireproofing material would surely be such as to invite those concerns manufacturing this material to make their profit on quantity rather than on one particular job. It is for them to say whether the future dwelling will be fireproof or not.

Comparative Weight and Cost per Square Foot of Wooden and Fireproof Floors.

(Compiled by the Bureau of Engineering of the Carnegie Steel Co.)

Wood Floor Construction, Based Upon 100 Lbs. per Sq. Ft. Total Load.

Description. Dimensions of floor space, ft.	Size of joists, in ins., for fiber stress 1,000 lbs. per sq. in.	Spacing of joists, c. to c., in.	Weight per sq. ft., lbs. Joists and bridging.	Flooring, etc.	Plaster and furring.	Total.	Cost per sq. ft., cts. Joists and bridging in place.	Flooring, etc., in place.	Plastering and furring, finished.	Total.
10 × 10	8 × 2	12	4.0	15	9	28.0	3.5	11.5	3	18 0
12 × 12	9 × 2	12	4.0	15	9	28.0	4.0	11.5	3	18.5
14 × 14	10 × 2	12	4.5	15	9	28 5	4.0	11.5	3	18.5
16 × 16	12 × 2	12	5.0	15	9	29.0	4 5	11.5	3	19.0
18 × 18	13 × 2	12	5.5	15	9	29.5	5.0	11.5	3	19.5
20 × 20	14 × 2	12	6.0	15	9	30.0	5.0	11.5	3	19.5
22 × 22	15 × 2	12	6.0	15	9	30.0	5.5	11.5	3	20.0
24 × 24	16 × 2	12	6.5	15	9	30.5	6.0	11 5	3	20.5
26 × 26	16 × 3	15	8.0	15	9	32.0	6.5	11.5	3	21.0

Fireproof Floor Construction, Based Upon 125 and 150 Lbs per Sq. Ft. Total Load.

Description. Dimens'ns of floor space, ft.	Size of steel beams for fiber stress, 16,000 lbs. per sq. in. In.	Lbs.	Spacing, c. to c. Ft.	In.	Weight per sq. ft., lbs. Steel construction.	Arches, flooring, etc.	Plaster.	Total.	Cost per sq. ft., cts. Steel construction in place.	Arches, flooring, etc., in place.	Plastering in place.	Total.
125 lbs. total load.												
10 × 10	6	13	5	0	3.0	42	6	51.0	6.5	24.0	2	32.5
12 × 12	7	15	6	0	3.0	44	6	53.0	6.5	24.5	2	33.0
14 × 14	7	15	4	8	4.0	44	6	54.0	8.5	24.5	2	35.0
16 × 16	9	21	5	4	4.5	52	6	62.5	10.0	28.0	2	40.0
150 lbs. total load.*												
18 × 18	10	30	6	0	6.0	56	6	68.0	12.0	28.0	2	42.0
20 × 20	12	32	6	8	6.0	67	6	79.	12.0	30.0	2	44.0
22 × 22	12	40	5	6	8.0	67	6	81.0	17.	30.0	2	49.0
24 × 24	12	40	4	9	9 5	67	6	82.5	19.5	30.0	2	51.5
26 × 26	12	50	5	3	10.5	67	6	83.5	22.0	30.0	2	54.0

* Taken on account of increase in dead load.

THE HOBB'S ISLAND CAR TRANSFER.*

The Hobb's Island transfer makes connection between Hobb's Island and Guntersville, Ala., which places are 20 miles apart, on opposite banks of the Tennessee River and on one of the lines of the Nashville, Chattanooga & St. Louis Ry. The plant consists of two stern-wheel steamboats of 40 and 90 tons burden, and two double-track barges, one for four and the other for six cars. The lighter boat conveys the passengers, and the other, with the barges, the freight. The time between Hobb's Island and Guntersville is two hours for the passenger boat and 2½ hours for the freight. At each terminal is an incline, at the foot of which is a cradle movable along the incline, so that cars can be run upon the barges at all stages of the water. The river has a rise and fall of 40 ft. at Hobb's Island and 47 ft. at Guntersville. The inclines are on a 3½% grade, on earth fill, pile trestle, riprap bank, and at the bottom a crib, where the nature of the river bed prevented driving piles. The incline at Guntersville is,

*Abstract of paper read Dec. 14 by Mr. G. D. Hicks, Division Superintendent of the Nashville, Chattanooga & St. Louis Ry., before the Engineering Association of the South.

in part, on a 10° curve. The cribs are built of 12 × 12 in. timbers, layers of 12 ft. lengths (8 ft. centers) crossing layers of 25 ft. lengths (3 ft. centers), all drift bolted. These cribs were loaded with stone, then capped by 12 × 12 in. stringers, laid to grade and bearing the 8 × 9 in. ties, 10 ft. long, doweled, the rails and the 5 × 9 in. guard rails.

The cradle at Guntersville is novel, in that it is constructed to move on a 10° curve, as well as on a tangent. It consists of eight sections on wheels and two on slides, each about 16 ft. long. The first section carries a 20-ft. apron and the last a feather rail. The sections are not rigidly connected, but by a bolt allowing about 5 ins. play. The rails are laid with opposite joints, spiked only at the joints and held together by tie bars. The rails outside on the curves are 1¾ ins. longer than those on the inside; on the tangent the openings thus formed between the shorter rails are each filled by a short section of rail inserted and held by a split key passing through its web and the splice plates. The bolt holes in the rails are slotted. The cradle at Hobb's Island is on a tangent. The cradles are moved along the incline by a locomotive or a steamboat. The connection between the apron and the barge is unusual. The ends of the rails on the apron are turned outward at about 30° at the junction, while the rails on the barge are at the end beveled at the same angle. The latter are held together by five tie-rods, the one nearest the beveled ends having a turnbuckle. Just back of this rod, a lever is arranged to lift the beveled rails clear of the apron, till the windlass has drawn the nose on the barge into the V on the apron, the gage having been lessened by the turnbuckle. Then the beveled rails are lowered into place and the gage restored by the turnbuckle, making the rails continuous from the barge to the cradle. The cost of the steamboats and barges was $30,368; that of the crib and cradle at Hobb's Island, $4,343 and $837, respectively, and at Guntersville $3,045 and $961, respectfully.

The 54 electric launches at the Columbian Exposition, says the "Engineering Magazine," made 56,207 trips, with an average daily run of 25.57 miles for each boat, or 168,621 miles in all. Between May 1 and Oct. 1 they carried 801,000 passengers. At 3 cts. per electric horse power the average cost of running one launch per day was 55.5 cts., and including the total cost for electricity, repairs, renewals, inspection and labor, but exclusive of office expenses, the daily cost per launch per day was $1.48, or 5¾ cts. per mile run.

The plans sent in for the proposed New York municipal building numbered in all 134. The board of advisory architects, made up of Prof. William R. Ware, Mr. Napoleon Le Brun and Mr. Edward H. Kendall, now reports that it has examined all of the plans and fails to find one perfectly satisfactory. Six plans have been selected as the best in respect to external appearance and internal arrangement, and it is possible that from a combination of these an acceptable plan might be drawn up. As matters stand, the Municipal Building Commission can report little progress toward an actual commencement of work.

The exhibit of the American Cement Co., of Philadelphia, Pa., at the World's Columbian Exposition included specimens of the new rock and limestones out of which Portland cement is manufactured in the Lehigh district of Pennsylvania, and of the marls and clays from which it is manufactured in the Syracuse district of New York State. The crushed materials, bricks ready for the kilns, burnt and crushed clinker and the finished cement, were also shown. There were also large photographs of the four works owned by the company, which works have a capacity of 2,400 barrels per day, and employ about 600 hands. Briquettes and a Fairbanks cement testing machine were included in the exhibit.

Plans for a highway bridge across the Brisbane River at Brisbane, Queensland, have been prepared by Mr. Alfred B. Brady, Engineer of Bridges for the colony. There will be six spans of 170 ft., with five piers, each composed of three cast iron cylinders filled with concrete and connected by bracing. The cylinders will be 10 ft. and 8 ft. diameter. The abutments will be of masonry and concrete. Each span will have three latticed steel trusses, with arched top chords, the depth of truss being 22 ft. at the middle and 10 ft. at the ends. The bridge will be 1,011 ft. 8 ins. long between abutments and 73 ft. wide between parapets, and the height above high water will be 25 ft. at the south end and 36 ft. 6 ins. at the north end. There will be two roadways 24 ft. wide between the trusses, and two sidewalks 9 ft. wide carried by cantilever brackets. The floors will be of transverse steel troughs 12 ins. deep, with broken stone and tar filling, ⅝-in. of asphalt and hardwood block pavement 6 ins. thick, with ⅝-in. asphalt joints. The sidewalks will have corrugated steel plate floors, with a filling of screenings and tar and a wearing surface of Val de Travers or Seyssel asphalt 1 in. thick. The parapets will be of wrought iron lattice work, and there will be ornamental gas lamp posts and other details. The bridge will carry a street railway, two 12-in. riveted steel water pipes and a conduit for electric telegraph and telephone wires. The bridge will be built with two trusses at first, and the additional cylinders will be sunk and trusses erected afterward. There will be about 1,860 tons of steel and 1,405 tons of iron in the structure. The cost is estimated at about $500,000. The contracts are expected to be let soon after March, and the work is to be completed in 2½ years. The material for the trusses will be imported, but the cylinders will be manufactured in the colony.

Land reclamation on a large scale is proposed in England, the project being to retain the land on the east coast now covered by the bay called the Wash. The width is 12 miles and the length about 15 miles, while the area covered is about 250 sq. miles. Four large rivers flow into the Wash, and their mouths are steadily silting up. As soon as the sandbanks rise to mean tide level the glasswort or samphire plant begins to grow, and not only prevents scour, but increases the silting. Already the bay is full of large sandbanks. In 1837 Sir John Rennie made a survey and report on the reclamation work, and proposed to straighten and deepen the river channels and form levees along the banks of the new channels, which would unite in one main channel leading to the sea. He estimated that the work would cost $10,000,000 and give employment to 20,000 men for 15 years. He also proposed that the reclaimed territory should form a new county. The improved channels would increase the facilities of the four ports on the Wash, and a harbor of refuge was proposed at the entrance to the main channel. The matter is being taken up now in connection with finding work for the unemployed, but whether it will be done (if at all) by the government or by a private company is not determined.

An automatic light, requiring no attendant and lasting for two months, has lately been put into a lighthouse on the estuary of the Gironde, France. The light is on an isolated rock in a treacherous reef, always difficult of access. The lantern is 56 ins. in diameter and cost $1,490. Ordinary mineral oil is burned at the rate of 50 grammes per hour and is automatically supplied from a double reservoir. The wick employed is three times the thickness of the ordinary lighthouse wick, and around the burning surface of the wick is a cake made of a patented compound consisting largely of carbonized tar. This preparation insures the duration and uniformity of the flame, and by its action cleans and draws up the wick. A chimney of mica surrounds the flame and increases the power of the light. The intensity of the light, which can be seen for 12 miles, keeps up for two months, when it must be visited and the wick replenished.

The first wire rope in the United States, says Mr. W. A. Roebling, in the "Bulletin" of the American Iron and Steel Association, was made in 1840 by Mr. John A. Roebling, at Saxonburg, Butler Co., Pa. This rope was ¾ in. in diameter and about 500 ft. long, and was used on a plane at Johnstown, Pa. It was made of parallel laid wires served on the outside with annealed wire. This rope went to pieces as soon as the serving wore out. The next rope was made for use on one of the incline planes of the Old Portage Railway, and was 1,500 ft. long and 1½ ins. diameter. It was constructed very much as wire rope is made now and lasted a long time. Its success introduced wire rope on the nine remaining Portage planes. The next application of wire rope on a large scale was on the planes of the Morris Canal, in New Jersey, soon followed by its adoption by the Delaware & Hudson Canal Co. Finding most of his business in the East, Mr. Roebling removed his plant from Butler Co. to Trenton in 1848.

Fast passenger steamers for lake service are being built by the Globe Ironworks Co., of Cleveland, O., for the Northern Steamship Co., and are intended to make the trip of 1,100 miles between Buffalo and Duluth in 60 hours, stopping at Cleveland, Detroit and Sault Ste. Marie. The service is in connection with the Great Northern Ry. The vessels are of steel, with double bottoms and numerous bulkheads, and the stern is so shaped as to inclose the screw shafts. Each vessel will have two quadruple expansion engines of 3,500 HP., with cylinders 25, 36, 51½ and 74 ins. diameter and of 42 ins. stroke. All cylinders have piston valves operated by the Joy valve gears. The engines drive four-bladed propellers 13 ft. diameter and 18 ft. pitch. There will be 28 Belleville boilers, arranged in three batteries, each battery being in a separate compartment and having its own forced draft plant and smokestack. The boilers are tested to 650 lbs. and intended to carry 250 to 300 lbs. working pressure. They are fitted with feed-water purifiers, steam separators, etc., and have the Etna shaking gates. Electric light and refrigerating plants are provided. The vessels are 380 ft. long over all, 360 ft. long between perpendiculars, 44 ft. beam, 26 ft. depth of hold, and will cost about $750,000 each. The first of these was launched on Jan. 6. Each vessel will have accommodation for 500 first-class passengers and 500 emigrants, but the freight capacity will be limited.

The proposed enlargement of the Erie Canal, with dimensions sufficient to permit the passage of light warships to the Lakes and grain in unbroken bulk from Duluth to Europe, is not approved of by State Engineer Schenck, in his late report. He estimates the cost of such an improvement at $500,000,000, and says that before it would be completed our present northern international boundary may have ceased to exist; and as to the trans-shipment of grain, the best informed shippers believe that the benefit to the grain by rehandling by elevators at Buffalo and New York largely compensates for the added expense. Mr. Schenck favors, however, an enlarged canal capable of carrying barges 250 ft. long and 25 ft. broad and drawing 10 ft. of water. His proposed canal would have a general surface width of 100 ft., where possible, and an alteration in the alinement, so that the greater part of the bridges passing over the canal would be fixed bridges instead of movable ones. He recommends boats built in two sections, for convenience of handling, and towed in fleets by powerful steam twin-screw boats, or by electricity. Such boats would carry 50,000 bushels of grain at a cost of 2 cts. per bushel from Buffalo to New York. He outlines the proposed route of the enlarged canal and believes that the ultimate cost of construction would not exceed $225,000,000.

There are 26 channeling machines in use on the Chicago drainage canal, of which 16 are Ingersoll-Sergeant machines, and besides these the Sullivan Machinery Co. has about a dozen machines at work on some of the sections cutting the channels by the foot under contract. The two types of machines are very much alike, and are the only ones on the direct-acting system, having the cutting tools attached rigidly to the piston rod. The old type of Wardwell channeler has a horizontal boiler, and the blow was dealt through levers operated by a horizontal engine. The Wardwell people introduced a vertical engine type, but the cutting tools were not rigid with the piston rod, there being a spring intervening. The Ingersoll-Sergeant machine weighs about 10,000 lbs., and is similar to a rock drill, except that the valve motion is controlled by a direct connection with the piston rod, which projects through the back head. The channeler strikes about 250 blows per minute and moves automatically along the track. Its capacity on the Chicago drainage canal is about 100 sq. ft. of channeling per day; that is, it will cut a channel 10 ft. deep and 10 ft. long, or 5 ft. deep and 20 ft. long in 10 hours. The machine has cut as high as 150 sq. ft. or more per day, but the general average is not over 100 sq. ft. The machine consists of a vertical boiler and engine mounted on a frame carried by four wheels with outside flanges, running on a track.

The Knapp car ventilating system now being tried on the Missouri Pacific Ry. was somewhat incorrectly described in the note in our issue of Dec. 21, which was taken from newspaper accounts. The device consists of a horizontal pipe under the car, extending nearly the length between the trucks, and tapering from the middle to a somewhat larger diameter at the ends. At the middle of the pipe a vertical pipe connects with an opening in the car floor. This opening is fitted with a grating and slide to regulate the draft. The current through the horizontal pipe when the car is in motion induces a downward current through the floor opening. A company is to be organized to manufacture the device and apply it to rolling stock. The inventor is Mr. Charles Knapp, Commercial Building, St. Louis, Mo. The object of making the horizontal pipe so long is not apparent, and it would seem to be necessary to use more than one opening in the car to secure efficient ventilation.

Corrosion of water pipes and other underground furniture by the ground return of electric railways continues to be reported. The recent annual report of the Brooklyn Electrical Subway Commission states that discoveries of corroded water and gas pipes have been of late so numerous that there seems no escape from the conclusion that metal pipes of all kinds extending below the surface along the routes of the trolley cars are being in many places destroyed by the ground currents. The lead covering of the telephone cables in the subways is also suffering from corrosion. Other instances of serious corrosion of telephone cables are reported from Cleveland, Louisville and Cincinnati. At Peoria, Ill., the Peoria Water Co. has formally notified the city authorities that its mains are being injured by the currents from the street railways, and unless these ground currents are removed the water company will refuse to make further

extensions of its mains or to be responsible for the maintenance of those now laid.

Bills for taxing sleeping, dining, buffet, refrigerator and fast freight line cars, are to be introduced into the Ohio Legislature at its next session. For sleeping cars the rate proposed is ½ ct. per mile for each car. Dining cars running entirely within state would pay $40 per year for the privilege of selling liquor, and buffet cars would be taxed $5 per year.

The hydraulic power supply system in London is making progress. Mr. E. B. Bihington, in a paper lately read before the Institution of Civil Engineers, said that in December, 1887, 609 machines were worked by this system of distributing power; in December, 1892, the number of machines was 1,755, and the length of mains had increased from 27 to 58 miles and the available horse power from 800 to 2,060. The system has been introduced into Liverpool and works are in progress in Manchester, Birmingham and several foreign towns.

Paper spindles, for yarn spinning, are now made as a substitute for the heavier steel spindles in ordinary use, thus economizing in motive power. In making these spindles common paper pulp stock is ran into a mold producing a spindle of four times the diameter fixed upon. This rough spindle is then compressed by hydraulic power in another mold to the size required, with the result that it is perfectly formed, hard and tough, with a surface that when polished is said to be as hard as metal.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

CENTRAL PENNSYLVANIA & WESTERN.—This company has filed a mortgage for $5,000,000 to build the projected line from Watsontown, Pa., the terminus of the Wilkes Barre & Western, to Williamsport, Pa., according to reports, and it is probable that the Wilkes Barre & Western will be extended from Orangeville to Wilkes Barre. This company is a consolidation of the Wilkes Barre & Western, Orangeville & Lehigh, and Turbotville & Williamsport, the last two companies having been incorporated to build extensions to the first named road. Gen. Man., S. B. Haupt, Watsontown, Pa.

NEW YORK, NEW HAVEN & HARTFORD.—A press report from New Haven, Conn., states as follows: The biggest piece of railway engineering in Connecticut has just been completed. In the new entrance route into this city the Shore Line division is now to pass through a tunnel. This tunnel is through extremely hard rock, and, although only 400 ft. in length, it has required some six months to complete it. The tunnel has been the most expensive piece of railway work ever undertaken in this part of the state.

OHIO SOUTHERN.—The extension from Springfield to Lima, O., has been opened for traffic, and it is stated that the line will be continued to Toledo in the spring.

OLD COLONY.—John D. Fouquet, New York, has prepared plans for eliminating the grade crossings within the city limits of New Bedford, Mass. Three schemes are proposed, the estimated cost of each of the first two being over $1,000,000. The report is being considered by the city council.

Projects and Surveys.

WISCASSET & QUEBEC.—The officials of this projected railway in Maine are reported as stating that a 2-ft. gage railway will be built this year from Wiscasset through Alna, Whitefield, Windsor, China, Albion, Benton and Unity Plantation to Burnham, 52 miles, and that a charter has been secured for a branch line from Week's Mills, in China, through East and North Vassalboro, Winslow and Oakland to the Somerset road. There will be no grade over 1½% and the cost of construction is not expected to be over $6,000 a mile. The bridge abutments and culverts will be of standard gage. No mortgage is to be placed on the road and no contracts awarded for sections over three or four miles in length. The awarding of a contract for rails was noted last week under Contract Prices.

Southern—Existing Roads.

CHESAPEAKE & OHIO.—Work is being pushed on the track on the south side of New River, between Hawk's Nest Thurmond, W. Va., according to reports, and it will be opened for traffic early this month. This gives the Chesapeake & Ohio three tracks over a large stretch of New River District, as there is already a long stretch of double track on the north side of the river. When the connection with Hawk's Nest is made this company will have about 125 miles of double track west of Clifton Forge, and it has practically 200 miles of double track east of Clifton Forge.

DRY FORK.—The grading on this road in West Virginia is reported as progressing rapidly and it is hoped to have the line in operation in the spring. Ch. Engr., John W. Moore, Jr., Elkins, W. Va.

NORTHAMPTON & HARTFORD.—About nine miles of this road have been completed, according to reports. The line extends from Gumberry, N. C., on the Seaboard Air Line, south to Mowfield and thence to Jackson, N. C. Gen. Man., F. Kell, Gumberry, N. C.

Northwest—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—It is reported that rails and ties have been collected at Liberal, Kan., for an extension to Trinidad, Colo.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA.—Surveys are being made, according to reports, for an extension from Bayfield, Wis., to Port Wing, a new lake town.

Southwest—Existing Roads.

PECOS VALLEY.—Press reports state that the construction of the extension from Eddy, N. Mex., to Roswell, 95 miles, will be commenced next month. This extension has been projected for several years. Ch. Engr., M. Harris, Eddy, N. Mex.

TEXAS & PACIFIC.—The laying of 60-lb. steel rails on the eastern division of this road has progressed to within 20 miles of Mineola, Tex., and will be carried on to Marshall as fast as possible. The rails taken up are being laid on the Rio Grande division west of Toyah, where the company still has over 100 miles of iron rails in use. A portion of the eastern division between Marshall and Texarkana has been newly ballasted with superior quality of gravel from the pits west of Texarkana Junction, and several cuts between Dallas and Mineola have also been changed. During the past year this company has laid over 600,000 new ties along its line, which is about the same quantity as was used in 1892.

Projects and Surveys.

RIO GRANDE & NORTHERN.—The directors of this company will meet Feb. 12 to consider an issue of $400,000 in bonds to build its proposed road from Van Horne, Tex., to the San Carlos coalfields. Ch. Engr., G. N. Marhall, El Paso, Tex.

Rocky Mt. and Pacific—Existing Roads.

COLORADO MIDLAND.—Reports from Canon City, Colo., state that bids are being received for extending the Midland Terminal from Cripple Creek south to that city, and that it is thought that the road will be built at an early date. This road will soon reach Cripple Creek from the North, but its extension south to Canon City would parallel the Florence & Cripple Creek road, the construction of which is now being rapidly pushed, as stated last week.

SAN DIEGO, YUMA & PHOENIX.—W. H. Carlson, Pres., has returned to Yuma, Ariz., from the city of Mexico, where he secured the right of way for 90 miles for this railway through Mexican territory, freedom from all taxes for 30 years and from duties for 15, and one of the most valuable concessions ever granted to an American company, according to press reports. He has been wired to go ahead, the money being ready to build the line. The road will run side by side with the Great Desert Canal for 40 miles. It will open the Yuma Indian reservation to settlement and the richest part of California now unsettled. It is expected to have the road completed to Phoenix, Ariz., 160 miles, within two years.

SOUTHERN PACIFIC.—A preliminary survey has been made for a branch line from south of Modesto, Cal., into the Yosemite Valley, a distance of 90 miles.

Projects and Surveys.

ROUND VALLEY & FORT BRAGG.—Geo. E. White, Round Valley, Cal., is interested in a proposed railway from that place to Fort Bragg, a coast port 60 miles distant. The road would give an outlet for some 30,000 acres of coal lands owned by John W. Mackay and Jas. L. Flood. It is reported probable that the construction of the road will be commenced in the spring and that the line will eventually be extended north to Eureka and southward to Ukiah, on the San Francisco & North Pacific.

Foreign.

MEXICO.—The railway between Lecolutla and Espinal, projected some time ago by Manuel Romero Rubio, father-in-law of President Diaz, is to be completed at once, the construction to be commenced this week, according to reports.

A press report from Chihuahua, Mex., states as follows: Alfonso L. Jones and Gen. Enrique A. Mexia have obtained a concession from the government for the construction of a railway from this city to the port of Mazatlan on the Pacific coast, with the right to construct branches to the coalfields in the state of Sonora. These same parties have also obtained a concession for the construction of a railway from the city of Guerrero to Chihuahua or some other point in this state, passing through a portion of the Sierra Madre Mountains and connecting with the Mormon colonies in the states of Coahuila and Chihuahua. Under the terms of the concession active construction work must begin within 18 months, and the entire system must be completed and in operation within 10 years. The survey of the lines will be commenced immediately.

STREET AND ELECTRIC RAILWAYS.

NEW BEDFORD, MASS.—The state board of railway commissioners has granted leave to the Union St. Ry. Co. to issue $350,000 of bonds and $350,000 of new stock to build the proposed electric railway between this city and Taunton, according to reports, and the line may be in operation by next July.

NORTHAMPTON, MASS.—The directors of the Northampton Electric St. Ry. Co. have voted to extend its tracks four miles to Easthampton and seven miles to Williamsburg, the line to Williamsburg to pass through Florence, Leeds village and Haydenville.

HARTFORD, CONN.—The Hartford Suburban R. R. Co. has been organized with David Henney as president and Wm. H. Goodrich secretary and treasurer. This company will include the Hartford & West Hartford R. R. Co., the Hartford & Middletown, the Windsor & Suffield, the Enfield & Somers roads and probably the Hartford Light & Power Co. The lines to New Britain and Unionville are under construction and contracts have been made for all the necessary supplies. Land on New Park Ave. has been bought for car houses, shops and other necessary buildings, on which work will be commenced this month. The $50,000 capital stock of the Windsor & Suffield R. R. Co. has been subscribed.

BROOKLYN, N. Y.—The state railroad commission has granted the applications of three new Brooklyn street railway lines for permission to use the electric trolley system, the lines being known as the Nassau Ry., the Kings County Electric Ry. and the Coney Island, Fort Hamilton & Brooklyn Ry. The applications had been pending since last July.

CANANDAIGUA, N. Y.—A press report states as follows: There is every probability that in the spring the Canandaigua Electric Light & Ry. Co. will construct an electric railway from this place through Shortsville to Manchester, the road connecting there with the Lehigh Valley. This road will carry both coal and passengers. The power will be supplied from the plant of the company at Littleville, which will also furnish electric lights for Palmyra and Canandaigua. The company is incorporated with a capital stock of $80,000, and the plant at Littleville has cost about $50,000.

FLATLANDS, N. Y.—The highway commissioners have granted a franchise to the Brooklyn, Bergen Beach & Canarsie R. R. Co. for an electric railway 18 miles long, beginning at Flatbush Ave., at the terminus of the Brooklyn City R. R., and extending to Bergen Beach, with a branch across country to the Canarsie shore. An electric plant to cost $30,000 is to be erected at Flatbush Ave. and Kings Highway. The contract states that work is to be commenced immediately, and it is expected that the road will be in operation early in the summer. The company is incorporated with a capital stock of $200,000; Pres., Percy G. Williams; Treas., Thomas Adams, Jr.

NEWARK, N. J.—The New Jersey Traction Co. and the Consolidated have united as the Consolidated Traction Co. and will commence at once the equipping of all its horse car lines to use electric motive power. Pres., F. C. Young, Jersey City; Gen. Man., David Young; Supt. Newark system, D. W. Sharpe.

PASSAIC, N. J.—It is reported that the contract for the construction of the electric railway between this city and Lake View has been awarded to Nelson & Cullen; also that for the double-tracking of the road between Passaic and Rutherford, where a single track is already laid.

PHILADELPHIA, PA.—The Philadelphia & Trenton Electric Ry. Co. has been incorporated to construct an electric railway to Trenton, N. J.; capital stock, $132,000; Pres., Walter N. Boyer.

ABERDEEN, MD.—A franchise for an electric railway between this place and Belair has been awarded to the U. S. Electrical Service Supply Co., Worcester, Mass., and ground has been secured for the erection of the power plant.

BALTIMORE, MD.—David M. Newbold, Pres., is reported as stating that all the contracts for the proposed electric railway to Washington will probably be awarded within a few days. This company controls the Eckington and Belt systems in Washington, and the gage of the road will be 4 ft. 8 ins., the same as of the Washington lines. The street railways in Baltimore have a gage of 5 ft. 4 ins. The road will be 28 miles long and the fare will be $1 for the round trip, the tickets containing coupons for free rides on any local street railway lines in this city.

ORLANDO, FLA.—It is reported that a new company has succeeded in securing the needed funds for building and equipping a street railway in this place.

LA SALLE, ILL.—The Inter-Urban Electric Ry. Co. has been incorporated by C. M. Palmer, R. M. Gardner and M. C. Vanfleet; capital stock, $250,000.

HAMILTON, ONT.—The directors of the Hamilton, Grimsby & Beamsville Electric Ry. Co., noted last week, are about to ask for bids for copper wire and to engage an electrical engineer, according to reports.

ELEVATED RAILWAYS.

PITTSBURG, PA.—The North Side Elevated R. R. Co., capital stock $50,000, has been incorporated to build an elevated railway from Allegheny to Bellevue, a distance of about five miles; and the Pittsburg Elevated R. R. Co., capital stock $100,000, to build an elevated railway from this city to Wilkinsburg, a distance of ten miles; Pres., John H. Dalzell, Allegheny; other directors, Joshua Rhodes, W. B. Rhodes, G. B. Hill, J. D. Nicholson, R. S. Frazer and A. M. Neeper.

HIGHWAYS.

COLORADO.—The Abeyta Pass Wagon Road Co. has been incorporated at Denver by P. W. Sweeney, A. M. Rice and J. P. Tarr; capital stock, $20,000.

OREGON.—Press reports from Chehalis, Ore., state that plans are being discussed for extending the Chehalis-Newaukum plank road to Jackson prairie and the Cowlitz territory. Considerable work has been done on this road the past season.

IDAHO.—The state wagon road commission has awarded contracts, at $114,500, for constructing a system of roads to connect the northern and southern sections of the state, according to reports.

BRIDGES AND TUNNELS.

BOSTON, MASS.—The council has voted in favor of an issue of bonds for $1,000,000 for a new bridge to Charlestown.

NEW BEDFORD, MASS.—The county commissioners are having final plans made for a steel bridge 70 ft. wide in this city, and the city council has engaged John D. Fouquet, New York, to examine and report upon the plans.

WATERBURY, CONN.—The committee on additional water supply will receive bids until Jan. 19 for four iron pipe line bridges, 45 and 60-ft. spans. R. A. Cairns, Cy. Engr.

NEW YORK, N. Y.—The department of public parks will receive bids until Jan. 18 for a viaduct approach from Ogden and Sedgwick Aves. to connect with Jerome Ave. approach to New Macomb's dam bridge over the Harlem River, now being built; superstructure will weigh about 1,100,000 lbs. and require 1,500 sq. yds. asphalt roadway; security required, $25,000.

SCRANTON, PA.—The council has passed the ordinance providing for an issue of bonds for $250,000 for the Roaring Brook and Linden St. bridges.

PORT GIBSON, MISS.—A three-span truss iron bridge, built a year ago by the Massillon Bridge Co. and known as the two-mile bridge, was washed away by a freshet Dec. 30. The bridge cost $7,190 and was guaranteed to stand five years, according to press reports.

COLUMBUS, O.—Bids will be received until Feb. 9

for the St. Clair Ave. viaduct over about 20 railway tracks. The bridge will be an eight-span plate girder, with 30-ft. roadway and two 8-ft. sidewalks. F. M. Senter, Clk. Bd. Pub. Wks.

CHICAGO, ILL.—The R. D. Wheaton Bridge Co. has been incorporated by R. D. Wheaton, G. F. Hoag and Chas. H. Wheaton; capital stock, $50,000.

QUINCY, ILL.—The Illinois Bridge Co. met at this city Jan. 3 and elected Amos Greer president, R. F. Newcomb vice-president and L. E. Emmons secretary and treasurer. It is proposed to unite with the Illinois Bridge Co. on the opposite side of the Mississippi River and to take steps to secure the construction of a wagon and railway bridge across the river at this place.

DES MOINES, IA.—Plans are nearly completed for the proposed Ninth St. viaduct.

DULUTH, MINN.—The contest over the proposed bridge between this city and Superior, Wis., became further complicated last week by the incorporation in Wisconsin of the Minnesota & Wisconsin Bridge Co., with an authorized capital of $100,000. The incorporators are J. W. Scott, ex-Mayor of Superior; Fred Beglinger, Treas. of Douglas county; J. H. Ager, and Alex. McRae. The company has prepared a bill providing for a steel bridge and free traffic for pedestrians and wagons, and has forwarded it to Washington for introduction.

KANSAS CITY, KAN.—The county commissioners have directed the county surveyor to prepare plans for a steel wagon bridge across the Kaw River at Turner station, to cost about $60,000. The bridge will have three spans and it is expected to commence the construction next month.

YANKTON, S. DAK.—A press report from this city states that the contractors who expect to build the railway bridge across the Missouri River at this place are here arranging the preliminaries. The bridge will cost $600,000, and will accommodate railways, teams and foot passengers. The bridge company expects to lease right of way to the Great Northern, the Yankton & Norfolk and the Omaha. Work is expected to be commenced upon the bridge within 90 days.

PHILLIPSBURG, MONT.—The Helena "Independent" quotes Col. W. Hart, of the Bi-Metallic Co., as stating that a contract will be awarded about Jan. 15 for a 7 × 4 ft. tunnel 7,000 ft. long to drain both the Bi-Metallic and Granite mines. The work is expected to give employment to about 100 men for 1½ years.

LITTLE ROCK, ARK.—Soundings and surveys are being made for the proposed free bridge across the Arkansas River at this place. The construction will be commenced at once and is expected to take two years; estimated cost, $350,000.

NEW BRAUNFELS, TEX.—Bids are asked until Jan. 25 for the construction of two wagon bridges, the bidders to furnish plans. Jos. Faust, Mayor.

DUNWICH, ONT.—Bids are asked for a Queen truss bridge over the Brooks Creek, on Talbot road. Engr., A. W. Campbell, St. Thomas. A. A. McKillop.

WATER-WORKS.

BOSTON, MASS.—The water board will receive bids until Jan. 31 for 30 to 4-in. pipe, as stated in our advertising columns.

BROCKTON, MASS.—The mayor has recommended that authority be secured to issue $100,000 of bonds for extensions of the mains to Cary Hill and Brockton Heights.

FALL RIVER, MASS.—The mayor has recommended that the tank system be extended. The city was authorized last spring to borrow $200,000, as stated last week.

HOLYOKE, MASS.—W. E. McClintock, Boston, has indorsed the report of Jas. L. Tighe in favor of the proposed supply from Munn's Brook, with a storage reservoir in Granville and a 24-in. conduit into Ashley ponds; estimated cost, $357,915.

MELROSE, MASS.—The town has voted to contract with the Middlesex Fells Springs Co. for a supply of 250,000 to 500,000 gallons per day for one year at 7½ cts. per 1,000 gallons, the present supply being inadequate.

NORTH ANDOVER, MASS.—The commissioners have been directed to postpone action relative to works until after the next annual town meeting.

PITTSFIELD, MASS.—The mayor has recommended extensions of the mains through Morningside to Pontoosuc, at a cost of about $30,000.

WALTHAM, MASS.—The mayor has recommended that a new covered reservoir be constructed, holding one-third as much as the present reservoir. It is thought that this would cost but little more than to cover the present one.

WESTFIELD, MASS.—Surveys are being made with a view to increasing the supply.

WEYMOUTH, MASS.—A town meeting will soon be held to authorize the commissioners to issue $50,000 of bonds.

NEW CANAAN, CONN.—We are informed by the New Canaan Water Co. that negotiations are being made for land and right of way for a supply from Five-Mile River. The works will include a reservoir 20 hydrants, and distribution system.

SOUTHPORT, CONN.—T. H. McKenzie, Southington, informs us that the surveys for works are in progress, but that no plans have yet been decided upon.

WATERBURY, CONN.—The city clerk will receive bids until Jan. 20 for $500,000 of 4% water bonds.

CHERRY CREEK, N. Y.—G. L. Martin, Vil. Clk., informs us that steps will probably be taken to secure works in the spring.

GILBERTVILLE, N. Y.—E. F. Musson, Norwich, is preparing plans for works.

HARRISON, N. Y.—The Harrison Park Water & Supply Co. has purchased the artesian well plant of the Iron Hall Land & Improvement Co. for $10,000, according to reports, and will add a stand-pipe and reservoir.

NEWTOWN, N. Y.—The town board has voted to contract with the recently organized company for 100 fire hydrants, at $25 each per year; the second 100 to cost $20 each and the third 100 to cost $15 each.

SOUTHAMPTON, N. Y.—The Southampton Water Co. is reported to have contracted with Oscar Darling, Engr., Huntington, to put in works to cost $50,000 and to be in operation before next June.

YONKERS, N. Y.—The board has voted to advertise for bids for about 250 tons of 24-in. and 200 tons of smaller pipe, and has instructed the engineer to prepare plans for laying a new supply main.

BURLINGTON, N. J.—Bids are asked until Jan. 16 for two 100-HP. tubular boilers, as stated in our advertising columns. Geo. A. Allinson, Supt.

JERSEY CITY, N. J.—Specifications have been prepared for laying 18,500 ft. of pipe on the hill and in the vicinity of Bidwell Ave.

NEWARK, N. J.—Bids are asked until Jan. 17 for the construction of a 235,000,000-gallon storage reservoir in South Orange, estimated to cost about $800,000. The work includes about 475,000 cu. yds. earth and 120,000 cu. yds. rock excavation, 42,500 cu. yds. concrete, 1,510,000 sq. ft. asphaltic cement and felt lining, and 170,000 sq. yds. brick paving, and is to be completed before Aug. 1, 1896. Chas. Marsh, Supt. Wks.

ALLENTOWN, PA.—The city engineer has reported that it will cost about $5,000 to enlarge the basin at the works.

ALTOONA, PA.—The Juniata Water Co. has been incorporated to supply water to Juniata Borough, Blair Co.; capital stock, $20,000; Treas., T. S. Davis. This item was referred to Dec. 28 under Juniata, but the postoffice of that name is in another county.

CANNONSBURG, PA.—A correspondent writes us that no steps have been taken to secure works.

PHILADELPHIA, PA.—There is talk of establishing a new pumping station on the William Weightman tract at the Falls of Schuylkill.

SOMERSET, PA.—The council has been restrained by temporary injunction from issuing bonds or contracting for works. The question of works has been under discussion for several years, and in December, 1891, the citizens voted in favor of the project. Two wells have been drilled and bids were to have been opened Jan. 6 for works.

WASHINGTON, D. C.—Bids are asked until Jan. 20 for fire hydrants and special castings, as stated in our advertising columns.

ABERDEEN, MD.—C. M. Johnson, Baltimore, has prepared plans for works, the supply to be from a creek two miles distant; estimated cost, $12,000 to $15,000; population, 1,000. A stock company is being organized. J. A. Swingley, Tn. Clk.

PORT DEPOSIT, MD.—Jacob Tome writes us that no estimates of proposed works will be made before May next; population, 2,000.

WINCHESTER, VA.—An election will be held Jan. 18 to vote on an appropriation of $30,000 for works.

WHEELING, W. VA.—The board has been authorized to extend the mains and furnish a supply to the town of Fulton.

YORKVILLE, S. C.—J. Ed. Jefferys, Tn. Clk., writes us that the contract for works was awarded in September to R. L. Coleman & Co., Columbia, at $16,000, and that the plant is nearly completed and ready for testing.

ATLANTA, GA.—W. R. Joyner, Ch. Engr. Fire Dept., wishes the city to lay another main from the reservoir to the city.

COLUMBUS, GA.—The council has received a letter from J. L. Ludlow, Raleigh, N. C., concerning plans for water and drainage systems, according to reports.

QUITMAN, GA.—The citizens have voted to issue $20,000 of bonds for works and electric lights.

VALDOSTA, GA.—The contract for works has been awarded to Robinson, Patrick & Co., Macon, the works to be completed by April 20. The pumps have been purchased of the Frictionless Metal Co., Richmond, Va.

BARTOW, FLA.—D. W. Stanley, Cy. Clk., writes us that an election will be held Jan. 18 to vote on the question of bonds for works. The supply would be from wells; population, 1,500.

NASHVILLE, TENN.—The board of public works is asking for bids for 65 fire hydrants, according to reports.

CYNTHIANA, KY.—The contract for two 1,000,000-gallon compound pumping engines, with boilers and all fittings, has been awarded to the Laidlaw-Dunn-Gordon Co., Cincinnati, at $6,237; stand-pipe, Springfield Boiler Mfg. Co., Chicago, at $7,300; receiving well, Guild & White, Chattanooga, Tenn., $1,800; pipe, Addyston Pipe & Steel Co., Cincinnati, $10,179; pipelaying, Guild & White, $5,385; valves and boxes Bourbon Copper & Brass Wks., Cincinnati, $700.

DANVILLE, KY.—Geo. C. Morgan, Chicago, is examining plans for works, and it is thought probable that the question of bonds will soon be voted upon; estimated cost, $65,000.

CLEVELAND, O.—The council is considering the question of a new pumping station east of the river.

COLUMBUS, O.—The following bids were received for eight steel boilers for the West Side pumping station: Columbus Machine Co., $7,300; Boeger Bros., $5,399; Scioto Boiler Wks., $4,948; Brownell Machine Co., Dayton, $5,881; Reeves Bros., Niles, $5,100; Variety Iron Wks., Cleveland, $5,536.

STEUBENVILLE, O.—The council has adopted plans prepared by Wilkins & Davison, Pittsburg, Pa., according to reports; estimated cost, $200,000 to $300,000. The present works were built by the town in 1835.

WAPAKONETA, O.—The Wagner Water Supply Co., Dayton, has offered to sink six or seven wells to secure a daily supply of 1,000,000 gallons, for $7,100.

WINTON PLACE, O.—The citizens have voted to issue $20,000 of bonds for laying mains in the village.

EVANSVILLE, IND.—The first prize of $1,000 for plans for works has been awarded to Wilkins & Davison, Pittsburg, Pa.

CENTRALIA, ILL.—The council has awarded the contract for works to Edmund T. Sykes, Minneapolis, at $35,483, according to reports.

EAST ST. LOUIS, ILL.—The City Water Co. has increased its capital stock from $750,000 to $1,500,000.

FARMINGTON, ILL.—An election was held Jan. 3 to vote on the question of works.

MADISON, ILL.—The village board has granted the Granite City Water Co. until July 1 for completing the works.

OTTAWA, ILL.—Works will probably be built in the spring, the plans calling for 200 hydrants, 25 miles of mains and a stand-pipe; estimated cost, $160,000.

ROCKFORD, ILL.—The city has contracted with J. J. L. Houston, Chicago, for a Pohle deep well pumping plant, having a daily capacity of 2,000,000 gallons. Water will be pumped from four non-flowing 8-in. wells, about 400 ft. deep.

STOCKTON, ILL.—A recent fire is reported to have renewed the agitation for works.

BERLIN, WIS.—Henry Morman, Cy. Clk., writes us that action on bids has been postponed until Jan. 17.

ONALASKA, WIS.—C. P. Moulton, Cy. Clk., writes us that at an election Dec. 26 it was voted to issue bonds for $15,000 for works.

HEMINGFORD, NEB.—The citizens have voted to issue bonds for $6,500 for works.

CORSICANA, TEX.—A mass meeting was held Dec. 29 to consider the question of a supply. It is reported that a water famine is imminent.

WAXAHACHIE, TEX.—C. W. Gibson and Osee Goodwin are members of a committee appointed to solicit subscriptions for the stock of a proposed company to put in works.

EVERETT, WASH.—The council has decided to call an election to vote on the question of purchasing the plant for $140,000.

SIDNEY, WASH.—The town has voted to issue bonds for $5,000 for works, the supply to be from artesian wells.

SPOKANE, WASH.—The lowest bids received Dec. 27 were as follows: Section A, dam, etc., Costello & Twohy, $194,444; B, water wheels, etc., R. A. Jones, $37,000; C, pumps, McKenzie & Glinn, $30,350; D, conduit, Costello & Twohy, $71,000. These contracts were awarded last month, as stated Dec. 14, but an injunction caused the work to be readvertised.

WALLA WALLA, WASH.—The city clerk has been directed to ask for bids for $160,000 of water bonds authorized last June for works.

REDLANDS, CAL.—The Lugonia Park Water Co. has been organized; capital stock, $50,000.

MONTREAL, QUE.—The council has appropriated $50,000 for laying water pipe during the winter.

ARTESIAN WELLS.

HOLYOKE, COLO.—It is reported that an artesian well will be sunk at this place as an experiment, and others if satisfactory.

IRRIGATION.

ORD, NEB.—The Burwell & Ord Irrigation & Power Co. has been incorporated with a capital of $100,000. Pres., Samuel L. Perkins; Vice-Pres., John W. Perry; Secy., H. C. Perry; Treas., P. Mortensen. The proposed canal, which has been already surveyed, is about 25 miles long. It begins seven miles north of Burwell and empties into Dane Creek at this place, according to press reports, and will irrigate 20,000 acres of fine agricultural land. The opportunity for obtaining a good water power is first-class, as the fall at Burwell is 45 ft., and at Ord over 112 ft.

SEWERS.

AMESBURY, MASS.—The merchants' association is investigating the question.

GLOUCESTER, MASS.—The mayor has recommended the construction of a system as soon as the financial condition of the city will permit of it. Surveys and plans have been made and the outlet will probably be into the ocean.

MELROSE, MASS.—The committee has been authorized to ask for bids for a sewer in Main St., to cost about $60,000. Plans have been prepared for a complete system, but no other work will be advertised until spring.

PITTSFIELD, MASS.—The towns along the Housatonic River are objecting to the pollution of that stream by sewage and methods are now being considered at this place for disinfecting the sewage.

HARTFORD, CONN.—Efforts are being made to commence work on the intercepting sewer, for which $375,000 has been appropriated.

WATERBURY, CONN.—The mayor has recommended the constructing of sewers in several streets. ——A commission will be appointed to investigate the question of sewage disposal and report plans.

JAMESTOWN, N. Y.—The board of public works will receive bids until Jan. 24 for about 51,000 ft. 8 to 18-in. pipe sewers, as stated in our advertising columns.

LONG ISLAND CITY, N. Y.—All bids were rejected for the Hoyt Ave. sewer and the work will be readvertised. The prices ranged from $140,000 to $190,000.

LAMBERTVILLE, N. J.—J. A. Anderson, Chn. Comn., writes us that the council is considering a report of the commission presented last month, but that no action has yet been taken on it.

ALLEGHENY, PA.—The following bids were received Jan. 4 for three main sewers, according to reports: Woods Run, J. H. McQuade, $230,446; Jos. Granini, $171,040; Keeling, Ridge & Co., $168,560; Ranson & Patton, $149,997; Dr. R. Lean, $149,405; Gwinner & Jones, $141,358; Hastings & McAfee, $130,402; C. I. McDonald, $125,060; Sloan & McIlwain, $124,959; H. C. Howard, $123,897; Standard Const. Co., $118,730.——Madison Ave., Qeeling, Ridge & Co., $158,500; Gwinner & Jones, $146,256; Standard Const. Co., $125,100; Sloan & McIlwain, $115,925.—East St., J. H. McQuade, $134,038; Gwinner & Jones, $116,727; Keeling, Ridge & Co., $113,525; Hastings & McAfee, $106,453, C. I. McDonald, $89,982; Standard Const. Co., $84,815; Jas. McSpadden, $83,550; Sloan & McIlwain, $83,215.

LEBANON, PA.—The following contracts have been awarded to Reilly & Riddle, the bids being as follows, 1, sewer in Seventh St., and 2, in Partridge Ave.:

	1.	2.
Reilly & Riddle	$8,104	$5,838
Millard & Bell	13,964	12,630
McGran & Almy	11,184	10,775
Adam Funck	11,524	.....
John E. Lyons	20,677	20,444
R. A. Malone	13,008	17,506
Frick, Weigelt & Co.	11,746	14,003
B. E. Malone	12,834	.....
Acock & Son	14,402	12,797

READING, PA.—Bids are asked until Jan. 29 for erecting a 5,000,000-gallon sewage pumping plant, the bidder to furnish plans and specifications for the same and also plans and estimates for a sewage disposal

and purification plant, as stated in our advertising columns. S. S. Hoff, Cy. Engr.

CARTHAGE, O.—Bids are asked until Jan. 22 for a sewer in Spruce St. T. C. Frost, Vil. Clk.

CINCINNATI, O.—The board of administration will receive bids until Feb. 1 for two sewers.

INDIANAPOLIS, IND.—The city engineer has been directed to prepare necessary papers for constructing seven sewers.

DES MOINES, IA.—Plans have been prepared for about 19 miles of sewers to be built the coming season, according to reports.

INDEPENDENCE, MO.—As soon as the topographical map, noted some time ago, is completed, it is reported that plans will be prepared and the question of a system submitted to a vote of the citizens.

LEXINGTON, KY.—The council has appropriated $200 for employing an engineer to examine the plans for a system.

STREETS.

BRIDGEPORT, CONN.—An additional appropriation of $60,000 has been asked for owing to the laying of double tracks by the street railway companies.

BROOKLYN, N. Y.—Bids are asked until Jan. 17 for grading and paving in Dean St. with cobblestones. J. P. Adams, Comr. Cy. Wks.

PITTSBURG, PA.—The question of issuing $6,000,000 of bonds for public improvements will be voted upon at an election Feb. 20.

WASHINGTON, D. C.—The citizens' relief committee has petitioned for an appropriation of $53,000 for immediate use for grading and improving streets.

ABERDEEN, MD.—The town is investigating the question of permanent roadways.

JACKSONVILLE, FLA.—The board of public works has voted to advertise for bids for paving several streets with brick, stone or sapless cypress blocks.

CINCINNATI, O.—The board of administration will receive bids until Jan. 27 for paving George St. with asphalt.

INDIANAPOLIS, IND.—The city engineer has been directed to prepare plans for improving several streets, including the paving of two each with brick and asphalt.

MILWAUKEE, WIS.—The Western Paving & Supply Co. has been organized by Frederick Kraus, Henry Weber and Jas. T. Bannan.

DES MOINES, IA.—The city paved 200,962 sq. yds. last year, at a cost of $330,967, and profiles have been prepared for establishing grades on 33¼ miles of streets during 1894.

ELECTRIC LIGHT AND POWER.

ENFIELD, N. H.—The citizens are reported as talking of putting in an electric light plant.

PITTSFIELD, MASS.—Capitalists of this city and Lenox are considering the organization of a company with a capital stock of $200,000 to utilize the water of Roaring Brook, which flows into the Housatonic River about halfway between the two towns. It is thought that 1,500 E. HP. can be developed, which would be used for lighting purposes.

BROOKLYN, N. Y.—Bids are asked until Jan. 16 for electric street lighting during 1894. John P. Adams, Comr. Cy. Wks.

NATCHEZ, MISS.—The contract for electric street lighting has been awarded to the Natchez Gas Co., at $115.50 per light per year. An effort was made to have the city secure the electric light plant and to do its own street lighting.

RICHMOND, IND.—The council has voted against municipal ownership and has awarded a 10-year franchise to the Richmond Light, Heat & Power Co., which is composed of Dayton, O., capitalists, and has a capital stock of $2,000,000.

DETROIT, MICH.—The public lighting commission will receive bids until Jan. 23 for constructing the necessary buildings for the proposed municipal electric light plant, and until Jan. 30 for the necessary engines, boilers, dynamos, etc.

FREMONT, NEB.—The canal project has been revised. It is proposed to employ J. W. Andrews to make a preliminary survey of a route to carry water from the Platte River into Elm Creek ravine, opposite the city, where by the construction of a dam a reservoir can be easily made and electricity generated for manufacturing purposes. A committee consisting of J. D. McDonald, E. N. Morse and J. C. Cleland has been appointed to raise funds to pay necessary expenses.

NEW COMPANIES.—The New York State Electric Co., Canisteo, N. Y.; $25,000; to manufacture electrical supplies; Clair House, M. Ekstromer, C. Hanlon.

CONTRACT PRICES.

PIPE.—Jersey City, N. J.—The contract for cast iron pipe has been awarded to the McNeal Pipe & Foundry Co., at $21.50 per gross ton. The bids were published last week.

STREET LIGHTING.—Warren, Pa.—A. Rogers writes us that the contract for street lighting for five years has been awarded at $87.50 per light per year for 25 arc lights of 1,200 c. p., each light to burn all night and every night, and $26.25 per light for 40 gas lamps, moonlight schedule.

ARCH BRIDGE.—Scranton, Pa.—The contract for a two-span arch bridge over the Lackawanna River at Connellton, in Old Forge township, has been awarded to C. R. Kinsley, Scranton, at $4.85 per cu. yd. for all kinds of masonry. The work will require about 800 cu. yds of rubble masonry in cement. A. B. Dunning, Jr., Co. Surv.

PUMPING ENGINE.—Columbus, O.—Press reports state that the only bid received for two 12,000,000-gallon duplex, compound condensing, crank and flywheel, horizontal pumping engines was that of the Holly Mfg. Co., Lockport, N. Y., at $183,000 for two Gaskill engines, exclusive of foundations, less $5,000 for the old machinery.

LEVEE WORK.—New Orleans, La.—The Tensas levee board has awarded a contract for 140,000 to 160,000 cu. yds of work to A. P. Martin, at 16 cts. per cu. yd. The contract is said to be one of the most important of the year, as it is for 7½ miles of extension of the Arkansas line of the district from the present head of the system to Amos Bayou, a stretch at present without protection.

DREDGING.—Portland, Me.—Col. P. C. Hains, U. S. Engineer Office, has received the following bids for excavating about 110,000 cu. yds from the channel in Back Cove, Portland Harbor: Moore & Wright, Portland, 16 cts. per cu. yd., measured in scow; Hamilton & Sawyer, Chebeague, 28 cts.; Chas. W. Anthony, Fall River, Mass., 14.5 cts.; A. B. Martin, Boston, 30 cts.; Chas. H. Souther, Boston, 25 cts.

ASPHALT PAVING.—Kansas City, Mo.—The amount of asphalt paving done in this city in 1893 was noted last week under Streets. The prices ranged from $2.20 to $2.80 per sq. yd. for 2 ins. asphalt, according to the foundation, the price on 4 ins. of concrete being $2.50. All the work was done by the Barber Asphalt Paving Co., which was required to furnish a bond equal to about three-fourths of the amount of each contract, and an additional guarantee bond of 50 cts. per sq. yd. to keep the pavement in good repair for five years. The work is paid for in special tax bills which are a lien on the real estate charged with the bills, and these tax bills may be paid in four annual installments and bear 7% interest. The work is done between April and December of each year and is both successful and acceptable, as is shown by the notable increase in the amount laid last year.

PIPE, CASTINGS AND VALVES.—Minneapolis, Minn.—The contract for a supply of cast iron pipe has been awarded to Dennis Long & Co., at $20.74 per ton of 2,000 lbs., as noted last week, the other bids being as follows: Radford Pipe & Foundry Co., $24.20; Howard-Harrison Iron Co., $22.14, or $15.50 f. o. b. cars at Bessemer, Ala.; Addystone Pipe & Steel Co., $20.98. The contract for special castings was awarded at 2 cts. per lb., other bids being at 2¼ cts. and 2⅜ cts. The bids for valves were rejected, the prices being as follows: Michigan Brass & Iron Works, 6-in. hub end, 82, weight 160 lbs., $10.80 each; 8-in., 2, 310 lbs., $16; 12-in., 11, 560 lbs., $32; 16-in., 3, without by-pass, 1,400 lbs., $55; with by-pass, 1,850 lbs., $70; 24-in., 5, with by-pass, 3,800 lbs., $175. Crane & Ordway Co., 6-in. Peet pattern, 160 lbs., $9; 8-in., 282 lbs., $15; 12-in., 680 lbs., $20.50; 16-in., with by-pass, 1,220 lbs., $105; 6-in., wedge, 130 lbs., $9; 8-in., 225 lbs., $15; 12-in., 500 lbs., $29.50; 16-in., with by-pass, 1,000 lbs., $105; 24-in., with by-pass, 2,400 lbs., $210. Rensselaer Mfg. Co., 6-in., 180 lbs., $11.20; 8-in., 300 lbs., $18; 12-in., 560 lbs., $32.50; 16-in., 1,240 lbs., $76; 24-in., 2,850 lbs., $165; 16-in., without by-pass, $65. Eddy Valve Co., 6-in. Eddy valve, 175 lbs., $12.50; 8-in., 300 lbs., $18; 12-in., 600 lbs., $34; 16-in., 900 lbs., $66; 24-in., 2,400 lbs., $175; 2-in. by-pass for or on 16 or 24-in. valves (additional), 150 lbs., $15; 3-in., 200 lbs., $20; 4-in., 250 lbs., $25. R. D. Wood & Co., 6-in. Eddy valve, $13; 8-in., $19; 12-in., $35; 16-in., $68 (3-in. by-pass $20 extra); 24-in., $180 (4-in. by-pass $25 extra).

MISCELLANEOUS CONTRACTS AND SUPPLIES.

FIRE APPARATUS.—Aberdeen, Md.—The village is reported as figuring on a fire department. J. A. Swingley, Clk.

PUBLIC BUILDING BONDS.—South Orange, N. J.—The committee on finance will receive bids until Jan. 15 for $16,000 of 5% public building bonds.

GAS LIGHTING.—Brooklyn, N. Y.—Bids are asked until Jan. 16 for furnishing illuminating gas for street lamps and public buildings for one year. John P. Adams, Comr. Cy. Wks.

DRAINAGE CANAL.—Chicago, Ill.—The drainage canal contract and machinery of the McCormick Construction Co. were sold in open court last week to Smith & Eastman, at $33,000 for the contract and all its reservations and privileges, and $8,000 for the dredging plant.

RETAINING WALLS.—St. Louis, Mo.—Bids are asked until Jan. 19 for building retaining walls at Harlem Creek and Hall St., the work requiring 780 cu. yds earth excavation, 88 cu. yds. stone masonry, 136 cu. yds. concrete, etc. Robt. E. McMath, Pres. Bd. Pub. Impvts.

PIER REPAIRS.—New York, N. Y.—The department of docks will receive bids until Jan. 18 for repairing the pier at the foot of West 44th St., the work including 120,660 ft. B. M. yellow pine, 84,866 ft. spruce and 3,858 ft. white oak timber; also four 60-ft. oak fender piles, 15,900 lbs. spikes, nails, etc.

FORT HARRISON.—Helena, Mont.—All preliminaries have been settled, according to reports, for the construction of Fort Harrison, for which work $250,000 is now available. In the spring work will be commenced on the post buildings, and it is probable that nearly the whole of this sum will be spent next year. The right of way to the fort has been secured for an extension of the electric railway, and the gas and electric companies and the Helena Consolidated Water Co. are reported as to extend their lines to the fort in the spring.

CANAL WORK.—Albany, N. Y.—The state engineer has recommended the following appropriations: For lengthening lock No. 20, $38,000; rebuilding new canal at Newark and substituting two locks for three, $300,000; improving the prism of the Oswego Canal and repairs to Battle Island dam and Phoenix dam, $50,000; survey of Erie Canal, $25,000. The construction of the proposed storage dam on the Genesee River is estimated to cost $850,000 to $2,100,000, according to plan, the last named price being for a dam 130 ft. high, which he recommends.

NATURAL GAS.—Lima, O.—Press reports state that Calvin S. Brice and Dr. S. A. Baxter are the projectors of a scheme to pipe natural gas from the Indiana gas fields to this city, Dayton, Springfield, St. Mary's, Van Wert, Lima, Sidney, Piqua, Troy, Covington, Versailles, Bremen, Minster, Urbana, Celina and a few other places. The undertaking has been in contemplation for about a year, according to the reports, and already between 10,000 and 20,000 acres of gas territory have been leased in Jay, Delaware, Blackford and Madison counties, Indiana.

PARK IMPROVEMENTS.—New York, N. Y.—The West End Association has prepared several plans for improving Riverside Park. One is the building of a viaduct in 96th St., across the park where the grade is very steep. It is also proposed to finish the construction of the retaining wall. The mayor is reported as stating that he will favor plans for the improvement of the park if they do not cost more than $250,000 a year.

Indianapolis, Ind.—Plans have been prepared for improving Garfield Park, the work including the construction of an artificial lake; estimated cost of stone dam, $5,000; excavation, $5,000 to $10,000.

WHARF EXTENSION.—Ottawa, Ont.—Bids are asked until Jan. 19 for constructing an extension to the wharf at Grande Riviere, Gaspe Co., Que. E. F. E. Roy, Secy. Dept. Pub. Wks.

INDUSTRIAL NOTES.

THE MILTON CAR WORKS, of Milton, Pa., have orders for oil tank cars for the Globe Refining Co., and for coal cars for the Baltimore & Ohio.

THE BROOKS LOCOMOTIVE WORKS, of Dunkirk, N. Y., are building eight engines for the Buffalo, Rochester & Pittsburg, and one for the Buffalo & Susquehanna.

THE COLORADO FUEL & IRON CO., of Denver, Colo., will probably start up its Bessemer steel works in March, on the order of 26,000 tons of rails for the Union Pacific and a large order for the Atchison, Topeka & Santa Fe.

THE MACK MANUFACTURING CO. is the new name of the company known as the John Porter Co., of New Cumberland, W. Va., and the general offices will be in the Telephone Building, Pittsburg, Pa. Increased capacity and improved machinery enable it to offer superior vitrified paving brick and block, fire brick and fire clay products.

THE UTAH PORTLAND CEMENT CO., of Salt Lake City, Utah, has nearly completed its new plant, at a cost of $35,000, for making Portland cement from lime shales on the Utah Central Ry. The plant will have a capacity of 100 barrels or 20 tons per day. Pres., J. R. Moorman; Secy., J. J. Campbell; Supt., Thomas C. Cairns; capital stock, $500,000.

THE LAIDLAW-DUNN-GORDON CO., of Cincinnati, O., has been awarded the contract for two compound pumping engines of 1,000,000 gallons capacity each, for Cynthiana, Ky., including boilers and all fittings. This is the twenty-first water-works contract taken by this firm since June 15, 1893, which contracts include 31 different engines.

THE NEW YORK MASTIC WORKS, New York, N. Y., are laying the floor of the grammar school on Forty-sixth St., between Sixth and Seventh Avs., New York, with Seyssel asphalt. Their Pittsburg agent, the Wadsworth Stone & Paving Co., has secured the asphalt work in the Ploeger, Black & Baird, Polish Parish and Heeren buildings and in the Phoenix Brewery, Pittsburg.

THE ANNISTON PIPE & FOUNDRY CO., of Anniston, Ala., has purchased the Anniston pipe works and will put them into operation at once. The works and yards cover 25 acres, and the company employs from 300 to 500 men. The daily capacity of the plant is 200 tons of pipe. Pres., F. C. Miller, Newport, Ky.; Gen. Man., J. K. Dimmock, Anniston; Secy., H. B. Cooper, Anniston; Treas., H. C. Pettro, New York, N. Y.

THE M. T. DAVIDSON steam pump works, of Brooklyn, N. Y., are running ten hours a day, with full force of men, and report that the outlook for 1894 is very promising. Several export sales of the Davidson pump have been made lately, and a number of important orders have also been placed in the United States. The works have a recent contract for two additional pumping engines at the city pumping station, Fall River, Mass., where there are already two Davidson engines in use.

THE CONSOLIDATED CAR HEATING CO., of Albany, N. Y., reports that it has begun suit against the Chicago & West Michigan Ry. for infringement of the Sewall coupler patents. The infringement consists of using an imitation of the Sewall steam coupler recently put upon the market. This railway is the first to continue the use of the imitation coupler after proper notification, and the company has determined to take action to protect the patents issued to D. D. and J. H. Sewall.

NEW COMPANIES.—American Construction Co., Chicago, Ill.; $250,000; James L. Perkins, Rufus Thompson and John B. Stannour.——Ferguson Contracting Co., East St. Louis, Ill.; $15,000; C. E. Barnes, E. E. Parks and Edwin L. Chapin.——Memphis Car & Foundry Co., Litchfield, Ill.; $600,000; C. F. Collins, H. H. Beach and John M. Maris.——Southern Fireproof Building Co., Richmond, Va.; $50,000; Pres., Reuben Shirreffs; Secy., G. G. Smith.——Martin & Fitts Lime & Cement Co., Brattleboro, Vt.; $25,000; James L. Martin, Clark C. Fitts and C. F. Thompson.——Western Construction Co. & Building Association, Lawrence, Kan.; $25,000; A. C. Mitchell, J. J. Cox and J. L. Brady.——New Jersey Blower Co., Newark, N. J.; $100,000; E. P. Backus, Houston Poole and W. B. Guild.——Nanticoke Gas Co., Pittston, Pa.; $25,000, with $2,500 paid in; Treas., J. W. Morris, Pittston, Pa.——Chicago Aluminum Co., Chicago, Ill.; $10,000; H. R. Platt, W. G. Webster and T. Blake.

METAL MARKET PRICES.

RAILS.—New York: $24.80 at eastern mills and at tidewater. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $13 for iron and $7.50 to $10 for steel.

TRACK MATERIAL.—New York: angle bars, 1.2⅝ to 1.4 cts.; spikes, 1.7 to 1.9 cts.; track bolts, 2.1 to 2.4 cts. with square and 2.3 to 2.5 cts. with hexagon nuts. Chicago: angle bars, 1.55 to 1.6 cts.; spikes, 1.9 to 1.95 cts.; track bolts, 2.55 to 2.6 cts. with hexagon nuts.

FOUNDRY PIG IRON.—New York: $12.50 to $14.25. Pittsburg: $11.25 to $12. Chicago: $12 to $13.50.

LEAD.——New York: 3.25 to 3.3 cts. Chicago: 3.05 cts.

NAILS.—Pittsburg: $1.10 to $1.30 for wire, 95 cts. at mill for cut.

STRUCTURAL MATERIAL.—New York: beams, 1.65 to 2.25 cts.; channels, 1.65 to 2 cts.; angles, 1.55 to 1.75 cts.; tees, 1.75 to 2 cts.; universal mill plates, 1.5 to 1.65 cts.; steel plates, 1.45 to 1.6 cts. for tank, 1.6 to 1.9 cts. for shell, 1.9 to 2.15 cts. for flange; 2.25 to 2.8 cts. for firebox. Pittsburg: beams, 1.45 to 1.6 cts.; channels, 1.45 to 1.6 cts.; angles, 1.45 to 1.5 cts.; tees, 1.7 to 1.75 cts.; universal mill plates, 1.45 to 1.5 cts.; steel plates, 1.35 to 1.37 cts. for tank, 1.55 to 1.6 cts. for shell, 1.65 to 1.75 cts. for flange, 1.85 to 1.95 cts. for ordinary firebox and 2 to 2.15 cts. for railway firebox. Chicago: beams, 1.65 to 1.75 cts.; channels, 1.65 to 1.75 cts.; angles, 1.6 to 1.65 cts.; tees, 1.9 to 2 cts.; universal plates, 1.6 to 1.65 cts.; steel plates, 1.55 to 1.65 cts. for tank, 1.75 to 1.85 cts. for shell, 1.95 to 2.05 cts. for flange, 2.75 to 3 cts. for firebox.